ECHNOLOGY DEPT.

TECHNOLOGY REVIEW

July 1958

No. 7 in a series

Right off the Wire

An application of television shows a pilot the image of his plane superimposed on a map of the territory over which he is flying.

An X-ray inspection method for solid cast rocket fuels reveals any cavities or fissures that would interfere with burning.

A new machine at Simplex applies Condex Interlocked Armor over cable cores having diameters up to 4.5".

An electronic guidance system will help river pilots to maneuver long strings of barges around the bends and under the bridges of the Mississippi.

A new facility for advanced research in thermonuclear reactions is expected to generate temperatures in the millions of degrees.

A land-mine exploder has been developed by the Army which will detonate buried explosives without damage to the exploder or the tank that carries it.

A new alkaline flashlight battery is said to last ten times as long as ordinary dry cells and to deliver more power.

A generator-powered flash-bulb holder is about the size of an electric razor. Half a turn of a wheel stores enough electricity in a capacitor to fire the bulb.

A television tube only five inches thick has been developed in England.

A process has been developed for electroplating copper on aluminum. The plating can be tinned, soldered or formed.

A new synthetic rubber is resistant to oils, fuels and solvents and retains its properties at temperatures as high as 400°F.

A new chemical compound slows the growth of any part of a tree without affecting the rest.

A new electronic instrument analyzes the sequence of chemical reactions in the burning of rocket fuels in one ten-thousandth of a second.

A single relay system across Canada from Halifax to Victoria will carry television programs and telephone conversations.

The floodlights at Niagara Falls have been redesigned to give ten times the illumination of the former twenty-five-year-old system with no increase in power consumption.

Further information on these news items and on Simplex cable is available from any Simplex office. Please be specific in your requests.

Among the United States exhibits at Brussels will be an outline of world history for the entire Christian era stored in a computer. Any item can be found in two-thirds of a second and printed in any one of ten languages.

The first digital computer fast enough to evaluate the performance of a missile in flight is said to be twenty-four times faster than preceding models.

A new X-ray technique reduces radiation exposure to a fraction of that now used for diagnosis.

A new truck transmission has twelve speeds in one gear box controlled by one lever.

A new machine can weigh and sort coins at the rate of 18,000 per hour with an accuracy of plus or minus one-fourth of one per cent.

A new desk-top machine covers one or both sides of documents with clear plastic film.

A device for practice in marksmanship shoots, instead of a bullet, a flash of light, which shows on the target.

An ultra-sensitive space speedometer measures acccleration in any direction.

A Simplex Laboratory

At the Simplex plant in Cambridge, six modern, well-equipped laboratories similar to the one shown here are devoted to the never-ending search for new, better materials and methods which result in new, better wire and cable products. Over the years, this program of concentrated, intensive research has brought about a great number of the most important technical advances and product improvements that have made Simplex the leader in the wire and cable industry.

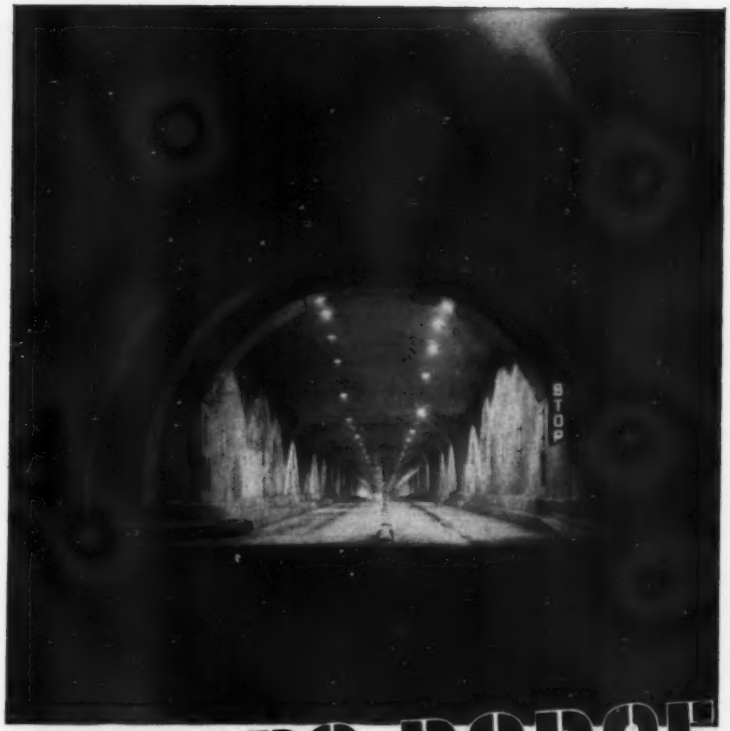
SIMPLEX WIRE & CABLE CO.
Cambridge, Massachusetts and
Newington, New Hampshire

Simplex

"The American manufacturers of transoceanic telephone cables"

N

Pennsylvania's Turnpike... Model for Modern Motoring



WIRE BY PHELPS DODGE

When the Pennsylvania Turnpike opened in 1940, it was the first modern highway of its kind in the East. Since then, it has earned a reputation as a model super-highway whose design combines a free flow of traffic with a low accident rate.

One of the requirements for the Turnpike tunnels, interchanges, approaches and portal buildings was an electrical system of the highest quality. That's why Phelps Dodge building wire and rubber insulated, neoprene-jacketed cable was installed. For 17 years, this wire and cable has been giving the Turnpike dependable, trouble-free service.

On every wiring job where top-quality performance, expert workmanship and experienced "know-how" are called for, *it pays to rely on Phelps Dodge and your Phelps Dodge distributor!*

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

THE TECHNOLOGY REVIEW, July, 1958, Vol. LX, No. 9. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00: Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

STAINLESS...for Moon Travel Tests?

The results of this welder's work may well be headed for the moon someday. For here his skills are being applied to a stainless steel component of ground propulsion test equipment as part of the missiles program. There can be no question about test equipment standing up. Hot formed from Type 347 stainless, this unit, one of a number, was welded and X-ray tested with Graver's modern techniques. When exacting design for missile testing is linked with Graver's skilled alloy fabrication, there's assurance of the quality demanded—in the same manner that Graver has served industry for over a century.

GRAVER®
ALLOY DIVISION

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA
New York • Philadelphia • Edge Moor, Delaware • Pittsburgh
Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston
New Orleans • Los Angeles • Fontana, California • San Francisco

The huge riverside crane at Combustion's Chattanooga Division, capable of lifting loads in excess of 250 tons, is about to ease the reactor vessel into a 195-ft. barge which will transport it via the Tennessee and Ohio Rivers to Cincinnati. From there it will travel by rail to the Enrico Fermi Atomic Power Plant at Lagoona Beach, Michigan — 30 miles below Detroit.

AMERICA'S LARGEST NUCLEAR COMPONENT

The nuclear reactor vessel shown here is the most remarkable stainless steel pressure vessel ever built. This 36-foot, 92-ton giant is the container for the nuclear furnace that will power the world's first full-scale, fast-breeder reactor power plant — the Enrico Fermi Atomic Power Plant. Designed by Atomic Power Development Associates, Inc., the nuclear section of this plant will be owned by Power Reactor Development Co., and the turbine-generator section by Detroit Edison Co.

Because of its vast size and complexity, the reactor vessel presented unique problems of design and fabrication. In reality, it comprises four separate cylindrical vessels welded together to form a single unit assembly, plus a large amount of internal shielding the fabrication of which involved the use of 65,000 square feet of stainless steel — all constructed and assembled with a precision never before attempted in work of this size and character. Additional parts of the vessel, scheduled for later shipment, will bring its total weight to about 200 tons.

No more than two or three plants in the world presently have the skills and facilities even to undertake the production of work of this kind. Combustion not only has the men and machines, but also the experience to produce such reactor vessels. Moreover, it is equipped and qualified to design and manufacture all other major components of complete nuclear power systems.

The Enrico Fermi Plant exemplifies the continuing, urgent drive by electric utility companies to generate electricity at the lowest possible cost, utilizing all developments modern science and technology can produce. Combustion is proud to have shared in this major step of the power industry to prepare itself for the age of the atom.

COMBUSTION ENGINEERING

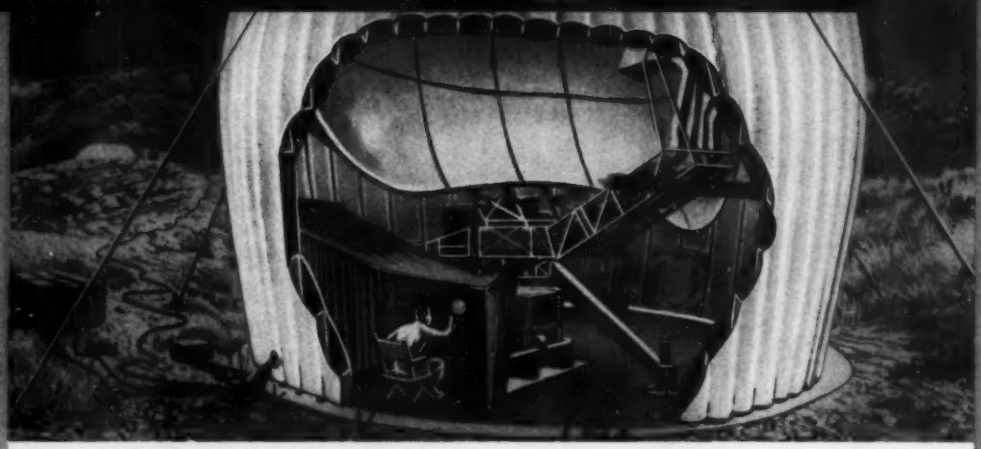
Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

C-158

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

ENGINEERS—

Another Example of Diversified Work SPERRY Engineers Do . . .



As fast on the move as a fighting Marine is the new "TEW" (tactical early warning) radar system being developed by Sperry for the Marine Corps. Only one-fourth the size and weight of conventional radars, TEW is easily carried to battle areas by helicopter, cargo plane, truck or amphibious vehicle. Within two hours, an 18-man crew can erect the TEW system and place it in operation.

With its very long range and portable construction, TEW provides the Marines with the means to extend the nation's defense perimeter and insure added protection for key installations and outposts.

If you're interested, not in an engineering job, but in an engineering CAREER, check Sperry—

Sperry Gyroscope also stands for steady growth. Not just for the company—but for its engineers. Sperry engineers are career engineers, working on projects—like TEW—that are creative, interesting, important. They stay, and grow, with us. That's why over 2,600 Sperry employees are 15-year men. And—today we're expanding, diversifying more than ever. If engineering is your life's work—check Sperry.

Openings in many specializations including the following:

INERTIAL NAVIGATION SYSTEMS
DOPPLER NAVIGATION • RADAR RECEIVERS
RADAR TRANSMITTERS • INFRARED SYSTEMS
PULSE CIRCUITS • TIMING CIRCUITS
ELECTRONIC PACKAGING
TRANSISTOR CIRCUITS
For Pulse & Video Applications
MICROWAVE ANTENNA DESIGN

Confidential Interviews

Contact Mr. J. W. Dwyer Employment Manager

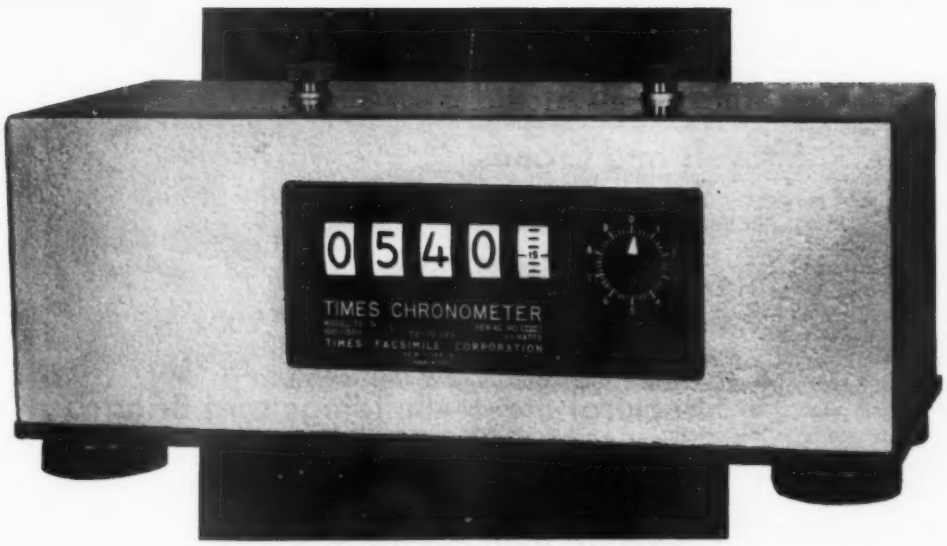
•

Saturday Interviews 8 A.M.-1 P.M. Arranged by Appointment

SPERRY
GYROSCOPE COMPANY
Division of Sperry Rand Corp.
Great Neck, Long Island, N.Y.
Fieldstone 7-3665

THE TIME INDICATOR UNIT

accurate to 1 second in 12 days



TIMES MODEL TS-3 CHRONOMETER

Program timer, pulse generator and clock. Timing assemblies, driven by the clock motor, provide momentary contact closings at rate of

• ONCE A SECOND • ONCE A MINUTE • ONCE AN HOUR

also constant frequency or pulse outputs as specified in range between 10 and 1000 cps.

PRICE: $950.00 F.O.B. Factory.
With added constant frequency output, $50 per output frequency.

TIMES FACSIMILE CORPORATION
540 West 58th Street, New York 19, N. Y.

MARITIME STEEL AND FOUNDRIES LIMITED

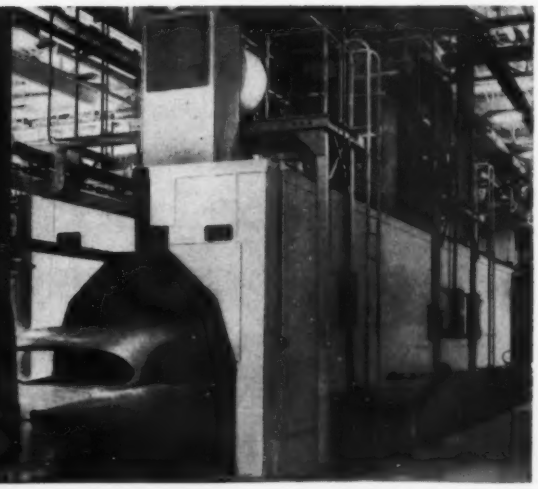
- Canadian manufacturers of P & H Power Shovels and Cranes
- Steel and Alloy Castings
- Structural Steel—Buildings and Bridges
- Custom-built Machinery

NEW GLASGOW, NOVA SCOTIA, CANADA

ROSS
Air Systems

Engineered Atmospheres for Better Processing

A Strong Merger and a continuing service on
ENGINEERED ATMOSPHERES



MIDLAND
STEEL PRODUCTS CO.

Late in 1957, two strong, well organized engineering and manufacturing companies merged. Midland Steel Products Co. and J.O. Ross Engineering Corporation became Midland-Ross Corporation. The service of Midland Steel Products carried them deeply into the automobile manufacturing and parts distribution field in connection with automobile and truck frames and automobile accessories. This service is continuing with added strength.

Early in 1958, Midland-Ross acquired another important company to broaden its service... Hartig Extruders, Mountainside, New Jersey, a company specializing in the design and manufacture of plastic extruders.

For thirty-five years, the work of J.O. Ross Engineering has been in the specialized field of Engineered Atmospheres, serving such industries as pulp, paper, automotive, rubber, glass, metal, textiles, drugs, chemicals, food, foundries, tobacco, plastics, wood ... industries where drying, curing, baking, spraying, heat-treating, humidifying and similar processing steps are key operations, often accompanied by comfort air-conditioning.

The term 'Engineered Atmospheres' covers the design, creating and installation of complete systems that provide the right kind of an 'atmosphere' in which to carry on these operations and the word 'atmosphere' is used both literally and figuratively. This involves a special kind of engineering—engineering experienced in the many phases of air-movements, heat generation and distribution, zone-control, impact, penetration, chemical reactions, solvent removal and recovery, heat-recovery, cycling, mechanical handling, electrical controls and drives.

In the above group of industries, Ross has served most of the major companies of the country.

M-R
MIDLAND-ROSS CORP.

THE MIDLAND-ROSS GROUP
OF COMPLEMENTING SERVICES

J. O. Ross Engineering, New York
John Waldron Corporation, New Brunswick, N. J.
Andrews and Goodrich, Boston
Ross Engineering of Canada, Limited, Montreal
Ross Midwest Fulton, Dayton
Hartig Extruders, Mountainside, N. J.
[illegible] Engineering Company, Ltd., England

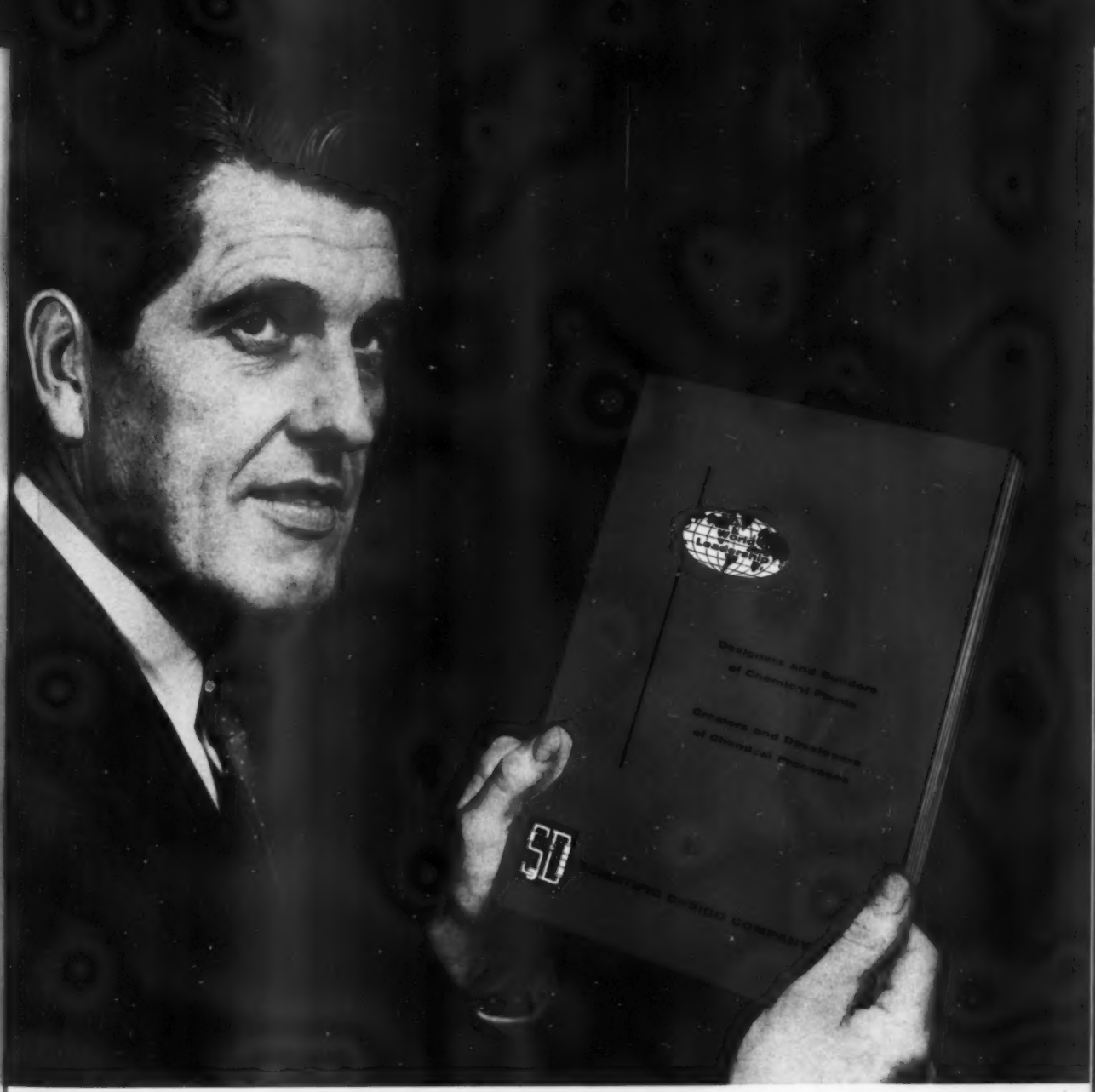
J. O. ROSS ENGINEERING DIVISION
Midland-Ross Corporation

444 Madison Avenue, New York 22, N. Y.
ATLANTA • BOSTON • CHICAGO
DETROIT • LOS ANGELES • SEATTLE

Olivetti office machines are made and assembled in eleven factories in six countries on three continents. Founded 50 years ago, Olivetti today employs 22,000 people, makes almost every major type of office machine, has sold 3,000,000 typewriters and 700,000 calculators.

In the United States, through dealers in principal cities, Olivetti offers printing calculators, adding machines, accounting machines and typewriters that provide many time-saving features. Write Olivetti Corporation of America, 375 Park Avenue, New York 22, N. Y.

The Olivetti Divisumma 24, a high-speed single-keyboard printing calculator with automatic constant and memory, combines many individual computations into a single continuing calculation, eliminating re-entries, saving time and work.



For the first time—THE SD STORY

Since its founding in 1946, SD has become on its performance record the world's leading independent company devoted exclusively to chemical process development and chemical plant design, construction and start-up.

In a new illustrated brochure, SD discloses for the first time the story behind this extraordinary record—SD's organization concepts, methods, key features, process portfolio, and *how SD specifically can serve you.* Copies of this informative brochure are available upon request.

It is my pleasure to invite you to send for our new brochure, shown above. I believe it will be of interest to management as well as technical men in the chemical process industries.

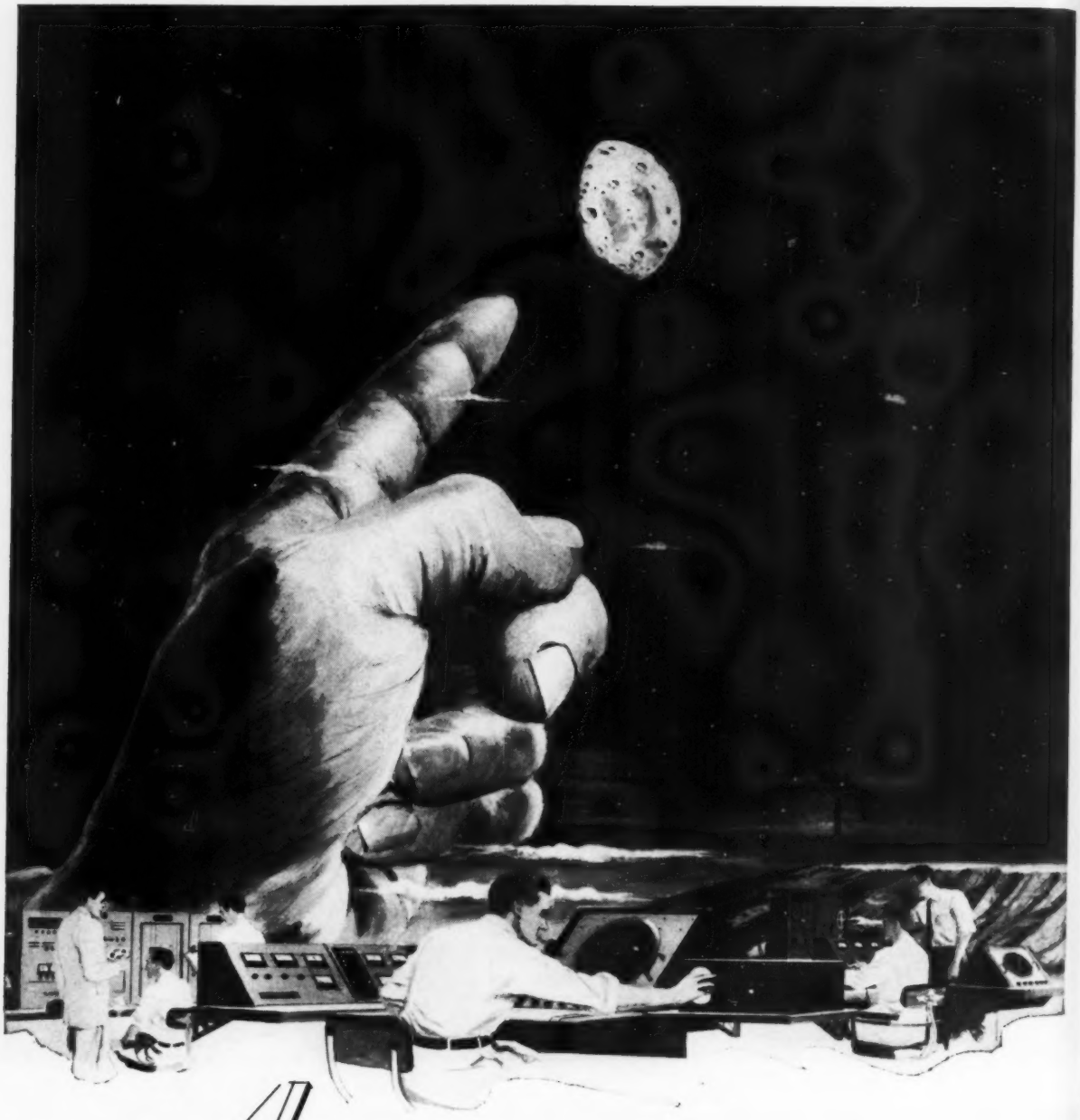
H. A. REHNBERG, PRESIDENT

Scientific Design Company, Inc.

CHEMICAL PROCESSES • PLANT DESIGN • CONSTRUCTION

Executive Offices: Two Park Avenue, New York 16, N. Y. • Engineering Offices: Jersey City, New Jersey

Research Center: Manorhaven, L. I., New York



An advanced concept

The Singer Manufacturing Company announces the formation of its Military Products Division, which through its three functional units, Haller, Raymond & Brown, Inc., Diehl Manufacturing Company, and Singer Bridgeport Division, can efficiently handle complex electro-mechanical and electronic programs from concept to completion.

THE SINGER MANUFACTURING COMPANY

Military Products Division

149 BROADWAY, NEW YORK CITY 6, N. Y.

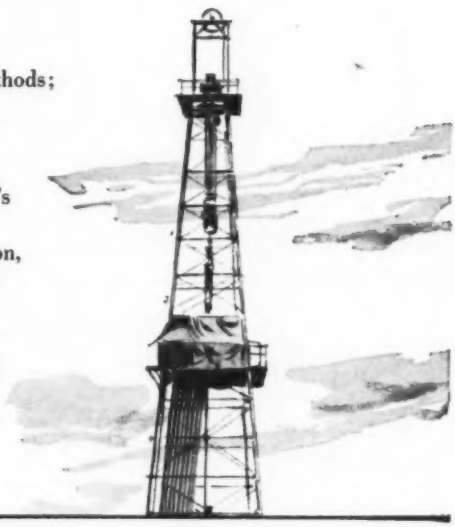
Petroleum, Humble and YOU

The petroleum industry requires keen, creative minds in its constant search for new oil reservoirs; for new and better techniques for producing petroleum on land and sea; for better, more efficient refinery methods; for new processes in the exciting petrochemical field.

Engineers and scientists at Humble share in the dynamic progress and growth of a leader in the petroleum industry. Humble Oil & Refining Company is the leading producer of crude oil in the United States. Humble's Baytown Refinery is one of the largest in the world. Research centers in Houston, for development of better methods of exploration and production, and at Baytown for research in refining, are making valuable contributions to the petroleum industry.

Because of their importance to the petroleum industry, engineers and scientists are given every opportunity for professional growth and personal advancement at the Humble Company. Guidance, lectures by leaders in various fields, and membership in professional societies afford each man valuable means of self-improvement.

At Humble, engineers and scientists grow . . . in their professions and in the Company.



HUMBLE OIL & REFINING COMPANY

HUMBLE

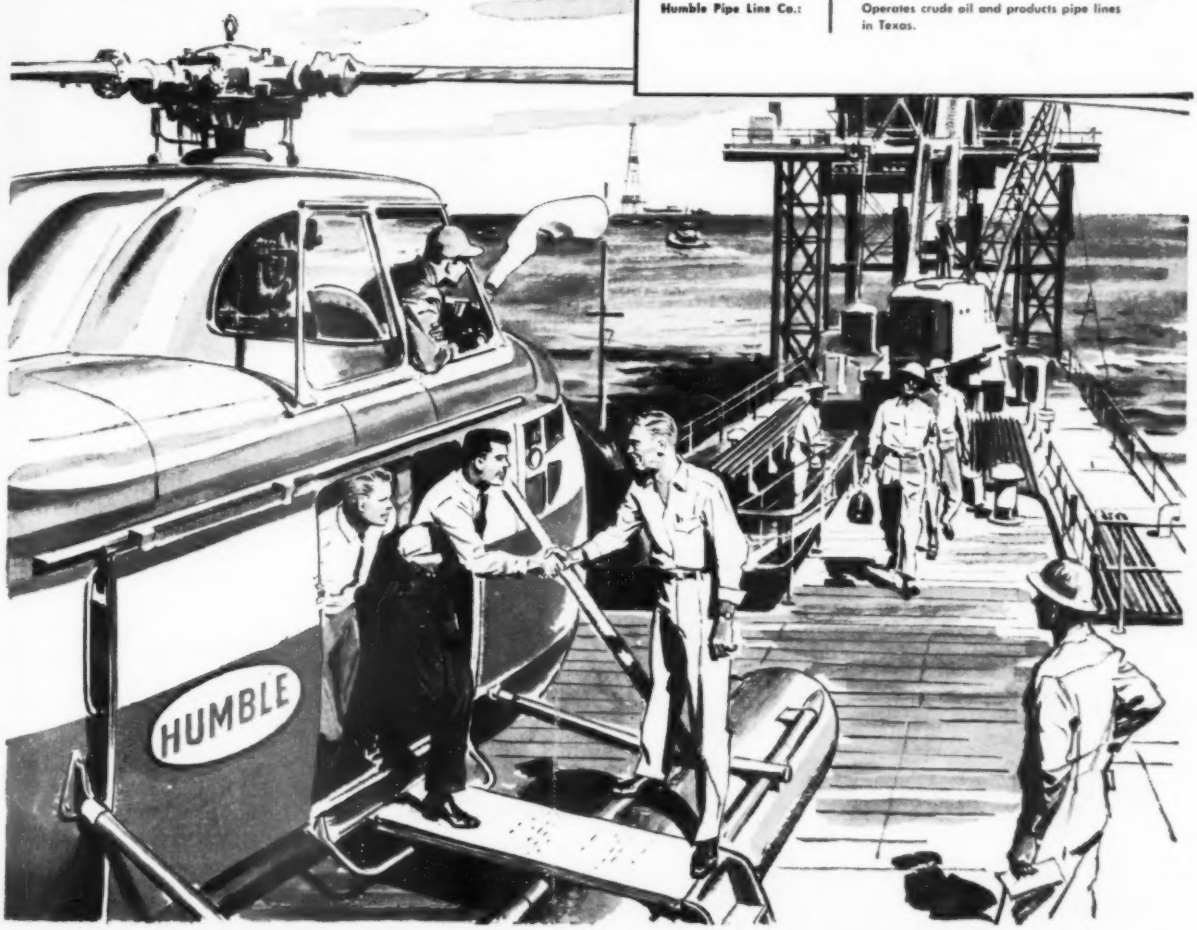
Refiners and Marketers of

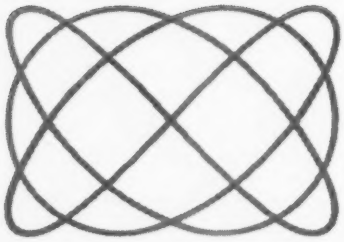
Esso Extra

Gasoline

A QUICK LOOK AT THE HUMBLE COMPANY

Area of Operation:	Texas, New Mexico, Florida, Alabama, Georgia, Mississippi, Louisiana, California, Washington, Arizona, Oregon, Alaska.
Refining Capacity:	280,000 barrels daily.
Retail Sales:	Texas and New Mexico. Leading Texas marketer.
Humble Pipe Line Co.:	Operates crude oil and products pipe lines in Texas.





PHYSICISTS

ENGINEERS

MATHEMATICIANS

are invited to join the Lincoln Laboratory scientists and engineers whose ideas have contributed to new concepts in the field of electronic air defense.

A brochure describing the following Laboratory programs will be forwarded upon request.

HEAVY RADARS

MEMORY DEVICES

TRANSISTORIZED DIGITAL COMPUTERS

SCATTER COMMUNICATIONS

SOLID STATE

AEW (air-borne early warning)

SAGE (semi-automatic ground environment)

SYSTEMS ANALYSIS

In certain of these programs, positions of significant professional scope and responsibility are open to men and women with superior qualifications.

Research and Development

MIT

LINCOLN LABORATORY
BOX 28
LEXINGTON 73, MASSACHUSETTS

THE TABULAR VIEW

Zest for Living. – In the baccalaureate address to members of the Class of 1958 (page 471), HAROLD L. HAZEN, '24, shows the strong correlation between intellectual curiosity and the meaning of a full life. Professor Hazen received the S.B., S.M., and Sc.D. degrees from M.I.T. in 1924, 1929, and 1931, respectively. He joined the Institute's staff in 1925 as research assistant, became assistant professor in 1931, associate professor in 1936, and full professor and head of the Department of Electrical Engineering in 1938. From 1934 to 1935, he was a member of the faculty of Ohio State University in the first of M.I.T.'s exchange professorships. He has been dean of the Graduate School since 1952.

Responsibility to Serve. – That education imposes heavy responsibility for service is emphasized (page 475) in the commencement address given this year by JOHN J. MCCLOY. Mr. McCloy has A.B. and LL.B. degrees from Amherst and Harvard, in addition to about a dozen doctorates. He was Assistant Secretary of War during World War II, president of the World Bank, 1947 to 1949, and U. S. High Commissioner for Germany from 1949 to 1952. He is at present chairman of the board, Chase Manhattan Bank; a director of four of the nation's largest corporations; and trustee of half a dozen foundations and medical and educational institutions. During World War I, he served as captain in Field Artillery, American Expeditionary Force. He holds the Distinguished Service Medal from the United States, and is grand officer, Legion of Honor (France).

Our Technological Strength. – Alumni and friends of M.I.T., who attended the luncheon on June 16, had the high honor of listening to an address by JAMES R. KILLIAN, JR., '26, Special Assistant to the President of the United States for Science and Technology. The Review is proud to present (page 479) Dr. Killian's address, which emphasized that today's exacting demands call for more engineers nurtured in an atmosphere of research. Dr. Killian is so well known and so highly regarded throughout the nation – and particularly to Review readers – that biographical data is quite unnecessary. We shall only say that our latest information is that he received another honorary Sc.D. degree in June – this time from Columbia University.

M.I.T. Progress. – The annual report to Alumni which has become a traditional part of Alumni Day events was presented this year by J. A. STRATTON, '23, who currently holds the doubly busy post of Acting President and Chancellor of M.I.T. Dr. Stratton's review of progress at the Institute (page 482) points to the need for understanding the complicated interrelations between technology and our society. Dr. Stratton has been Acting President since President Killian was granted leave of absence for an important assignment in Washington.

Lesson for America. — Intellectual power is as vital as horsepower, according to MORRIS COHEN, '33. Speaking at the Alumni Day symposium, Dr. Cohen told his audience that a more profound educational approach is required – in which scientific analysis becomes part of our nation's normal thought processes. Professor Cohen's remarks, which The Review is happy to present (page 483), are based on observations of a trip to the U.S.S.R.

(*Concluded on page 446*)

CHEMICAL PROCESS?

Special Know-How Needed?

UHDE

Have You Tried Germany?

The Uhde Corporation is associated with Friedrich Uhde GmbH, design subsidiary of the Farbwerke Hoechst AG group of German chemical companies.

HOECHST

CHEMICAL PROCESS DESIGN

THE UHDE CORPORATION

350 FIFTH AVENUE, NEW YORK 1

ENCLOSURES
DEEP DRAWING
FORMING
FABRICATING
FINISHING

ALL METALS

80-TH YEAR
OF PRESSED
METAL SERVICE
TO INDUSTRY

DESIGNERS ●
ENGINEERS ●
MANUFACTURERS ●

FROM TOOLING
TO END PRODUCT

PETER GRAY CORPORATION
284 THIRD STREET
CAMBRIDGE 42, MASSACHUSETTS

custom-built equipment for the mechanical and process industries

We develop special equipment and machines from ideas to blueprints — to prototypes — to pilot plants — to the final product or process. Our technical staff and plant facilities are geared to handle the most intricate jobs all the way from small scale laboratory equipment up to contracts in excess of $1,000,000.
Phone TWinbrook 3-6800 or write to:

Artisan METAL PRODUCTS, INC.
73 POND STREET, WALTHAM 54, MASS.

For a comprehensive summary of our work and the equipment we make, write for our brochure "Process Equipment".

Designers and manufacturers of
AUTOCLAVES · CONDENSERS AND HEAT EXCHANGERS · DISTILLATION EQUIPMENT · EXPERIMENTAL EQUIPMENT · EVAPORATORS · JACKETED KETTLES · MIXERS · PIPE, PIPE COILS, AND BENDS · REACTORS · SPECIAL MACHINERY · TANKS

THE TABULAR VIEW

(*Concluded from page 444*)

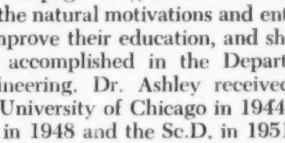
last winter. Dr. Cohen received the S.B. and Sc.D. degrees from M.I.T. in 1933 and 1936, respectively, and has been in the Department of Metallurgy since his student days. In 1945, and again in 1949, he received the Howe Medal from the American Society for Metals.

Research in Education. — As undergraduate training in technical subjects becomes progressively more scientific, stronger programs for engineering instruction are under study and are being developed. This was the principal message delivered by EDWIN R. GILLILAND, '33, in his symposium address, which The Review is pleased to present (page 489). Dr. Gilliland has been at M.I.T. since 1933, when he received his Sc.D. degree. He is coauthor of several books, recipient of a number of awards in chemical engineering, and has held a variety of important teaching and administrative posts at M.I.T.

Wild Blue Yonder. — In his symposium address (which The Review presents on page 491), HOLT ASHLEY, '48, urged capitalizing on the natural motivations and enthusiasms of students to improve their education, and showed how this was being accomplished in the Department of Aeronautical Engineering. Dr. Ashley received the B.S. degree from the University of Chicago in 1944, and from M.I.T. the S.M. in 1948 and the Sc.D. in 1951. He has been a member of the National Advisory Committee for Aeronautics, became associate professor of aeronautical engineering in 1954, and two years later was one of 10 "outstanding young men" selected by the Boston Junior Chamber of Commerce.

The Review is not published during the summer months following July. This issue, therefore, concludes Volume 60. Number 1 of Volume 61 will be published on October 27 and dated November. Readers who bind their copies are reminded that if they possess nine issues of Volume 60, their files are complete. An index to the volume will be ready on September 15 and will be supplied post free upon request.

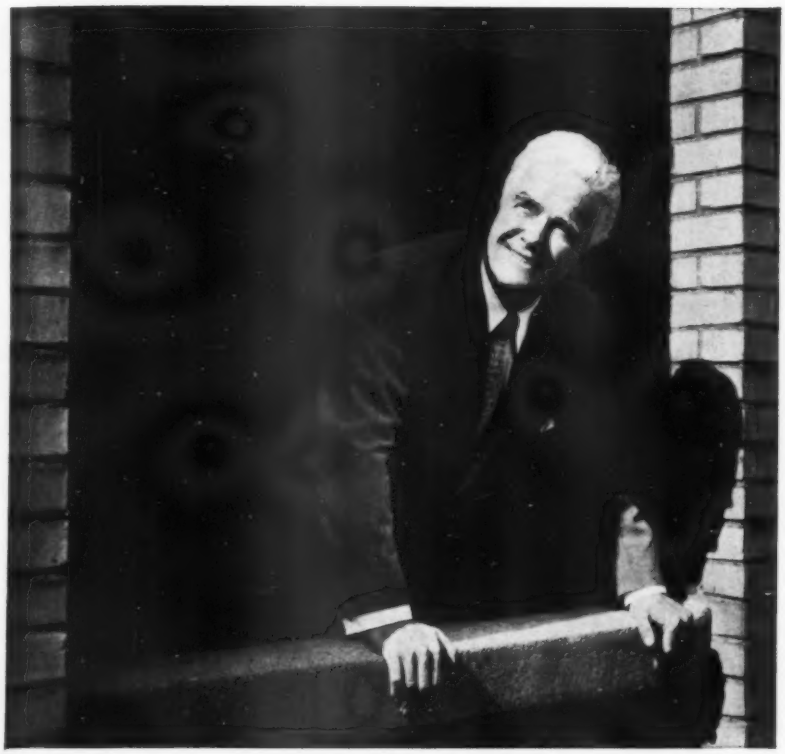
E. A. Laboratories, Inc.



PRE-TESTED

Our ability to build quickly and well has been pretested for you by over 1,200 contracts for leading companies. More than 70% of the contracts awarded us are from those for whom we have previously built.

W. J. BARNEY CORPORATION
Founded 1917
INDUSTRIAL CONSTRUCTION
101 Park Avenue, New York
Alfred T. Glassett, '20, President



Bought Blue Sky ...Reaped Profit

Some industries invest in electrical precipitators for one reason only—to avoid creating smoke nuisance. Blue sky—clean stack discharge from a plant—is a good advertisement, basic in any factory community relations program.

But here is an instance where electrical precipitators pay high *cash* dividends as well. A major producer of pulp and paper uses 22 Cottrell Precipitators, installed by Research Corporation, to recover salt cake from various processes. Over 150,000 tons of this chemical are thus reclaimed each year for re-use—$3,000,000 that goes on the happy side of the ledger rather than up the stacks.

In a case like this, the collection efficiency of the equipment is of high dollar importance, just as it is in oil refineries where catalyst is recovered . . . in chemical plants where sulphuric and phosphoric acids are recovered . . . and in non-ferrous smelting plants where escape of valuable metallic dust and fume is prevented.

The higher the efficiency, the bigger the pay-off . . . or the cleaner your stacks will look, if your objective is nuisance abatement. But how do you make sure of getting highest efficiency?

First, remember that electrical precipitators are no simple, standard device. For best results, for true economy, each installation must be custom engineered. And that engineering should be based on successful past experience in meeting similar requirements and conditions.

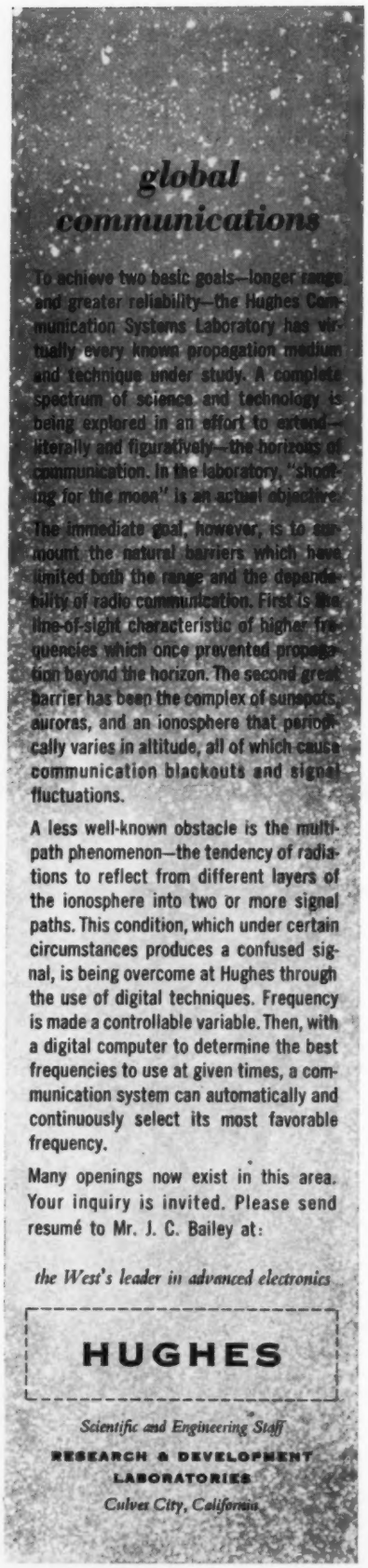
The designer-builder with by far the largest total and broadest-ranging experience is Research Corporation. Research has designed and sold more than 2000 precipitators during the past 40 years. This experience is available to help you solve your problem, whether it's gas cleaning, nuisance abatement, recovering valuable materials, or, perhaps, some precipitator application that has never been attempted before.

Your questions will be welcomed—and please be sure to write for a copy of Bulletin GB, a quick summary of dust collection problems and facts of interest to management men.

RESEARCH-COTTRELL, INC.
Main Office and Plant: Bound Brook, N. J.
405 Lexington Ave., New York 17, N. Y.
Grant Building, Pittsburgh 19, Pa.
228 N. La Salle St., Chicago 1, Ill.
111 Sutter St., San Francisco 4, Cal.

Dr. Joseph W. Barker, '16,
Director

V. P. Cook, '35,
Field Engineer


global communications
To achieve two basic goals—longer range and greater reliability—the Hughes Communication Systems Laboratory has virtually every known propagation medium and technique under study. A complete spectrum of science and technology is being explored in an effort to extend—literally and figuratively—the horizons of communication. In the laboratory, "shooting for the moon" is an actual objective.
The immediate goal, however, is to surmount the natural barriers which have limited both the range and the dependability of radio communication. First is the line-of-sight characteristic of higher frequencies which once prevented propagation beyond the horizon. The second great barrier has been the complex of sunspots, auroras, and an ionosphere that periodically varies in altitude, all of which cause communication blackouts and signal fluctuations.
A less well-known obstacle is the multipath phenomenon—the tendency of radiations to reflect from different layers of the ionosphere into two or more signal paths. This condition, which under certain circumstances produces a confused signal, is being overcome at Hughes through the use of digital techniques. Frequency is made a controllable variable. Then, with a digital computer to determine the best frequencies to use at given times, a communication system can automatically and continuously select its most favorable frequency.
Many openings now exist in this area. Your inquiry is invited. Please send resumé to Mr. J. C. Bailey at:
the West's leader in advanced electronics
HUGHES
Scientific and Engineering Staff
RESEARCH & DEVELOPMENT LABORATORIES
Culver City, California

INDEX TO ADVERTISERS

July, 1958

Advertiser	*Page*
A	
Aerofin Corporation	522
Albert Pipe Supply Company, Inc.	524
Allied Research Associates, Inc.	508, 509
Artisan Metal Products, Inc.	446
B	
Barney Corporation, W. J.	446
Beacon Construction Company of Massachusetts, Inc.	521
Bludworth Marine	515
Boston Manufacturers Mutual Insurance Company	519
Brewer Engineering Laboratories	535
Brook Motor Corporation	532
C	
Caldwell, Inc., R. W.	527
Capitol Engineering Corporation	535
Castle Rubber Company	528
Chance Vought Aircraft Inc.	458
Chauncy Hall School	534
Cleverdon, Varney and Pike	535
Coburn and Company, William H.	528
Combustion Engineering, Inc.	435
Converse Rubber Company	456
Curtis Universal Joint Company, Inc.	520
D	
Damascus Tube Company	453
DeBell and Richardson, Inc.	450
Debes and Associates, Charles Nelson	535
deFlorez Company, Inc., The	534
Dexter Chemical Corporation	518
Diefendorf Gear Corporation	520
Douglas Aircraft Company	461
Drake and Townsend, Inc.	521
Dwight Building Company, The	529
E	
Eadie, Freund and Campbell	535
F	
Fabric Research Laboratories, Inc.	535
Fay, Spofford and Thorndike, Inc.	535
Ferguson Electric Construction Company, Inc.	529
Ferre Industries	518
Fitchburg Paper Company	459
Fletcher Company, H. E.	514
Flush-Metal Partition Corporation	Inside Back Cover
Forte-Fairbairn Inc.	533
G	
Gannett Fleming Corddry and Carpenter, Inc.	535
General Radio Company	Outside Back Cover
Gilbert Associates, Inc.	535
Goodyear Tire and Rubber Company, The	462
Graver Tank and Manufacturing Company, Inc.	434
Gray Corporation, Peter	446
H	
Hart Products Corporation, The	533
Haskell-Dawes Machine Company, Inc.	521
Haydon Division of General Time Corp.	506
Hevi-Duty Electric Company	504
Higgins Ink Company, Inc.	515
Hinde and Dauch	526
Holmes and Narver, Inc.	534
Hoosier Tarpaulin and Canvas Goods Company, Inc.	529
Hubbell, Inc., Harvey	527
Hughes Aircraft	448
Humble Oil and Refining Company	443

(*Continued on page 450*)

Page

.. 522
.. 524
8, 509
.. 446

.. 446
.. 521
.. 515
.. 519
.. 535
.. 532

.. 527
.. 535
.. 528
.. 458
.. 534
.. 535
.. 528
.. 435
.. 456
.. 520

.. 453
.. 450
.. 535
.. 534
.. 518
.. 520
.. 461
.. 521
.. 529

.. 535

.. 535
.. 535
.. 529
.. 518
.. 459
.. 514
s Cover
.. 533

.. 535
k Cover
.. 535
.. 462
.. 434
.. 446

.. 533
.. 521
.. 506
.. 504
.. 515
.. 526
.. 534
.. 529
.. 527
.. 448
.. 443

TRAVEL SERVICES FOR YOU AND YOUR INVESTMENTS

If you are planning a trip or an extended vacation, there are many ways we can serve you.

We can provide letters of credit and travelers cheques.

We can furnish letters of introduction to our correspondent banks in the places you plan to visit, and information about exchange rates in countries overseas.

We can protect your valuables and important papers in our safety deposit vaults.

We can provide *take-care-of* services for your investments. Our Booklet "Agency Service — Experienced Management for Your Investments" has helped many people in their consideration of this important matter. If you are interested, we will be glad to send you a copy of "Agency Service" — no obligation, of course.

Why not take advantage of our varied travel services? We would welcome the opportunity.

Whatever your banking or trust needs,
you're welcome at

SECOND BANK-STATE STREET Trust Company

HEAD OFFICE:
111 FRANKLIN STREET
Richmond 2-4500
Boston, Massachusetts

Member Federal Reserve System • Member Federal Deposit Insurance Corporation

INDEX TO ADVERTISERS

(*Continued from page 448*)

Advertiser	*Page*
I	
International Business Machines Corporation	454
J	
Jackson and Moreland, Inc.	535
Johnson Service Company	455
K	
Kinney, Inc., A. M.	515
Kohler Company	516
Kuljian Corporation, The	535
Kusko, Inc., Alexander	534
L	
Liquid Carbonic, Division of General Dynamics Corp.	522
Lockwood Greene	534
Lombard Governor, Corp.	452
Lummus Company, The	507
M	
Main, Inc., Chas. T.	527
Manufacturers Mutual Fire Insurance Company	523
Maritime Steel and Foundries Ltd.	438
M.I.T.—Gifts by Will	536
M.I.T. Lincoln Laboratory	444
Meissner Engineers	534
Metcalf and Eddy	535
Meyne Company, Gerhardt F.	521
Moran, Proctor, Mueser and Rutledge	535
N	
New England Transformer Company, Inc.	510
Nicholson Company, The	452
O	
Olivetti Corporation of America	440
P	
Phelps Dodge Copper Products Corporation	433
Pontiac Motor Division of General Motors Corporation	460
Precision Products Company Inc of Waltham	524
Process Equipment Company, Inc.	529
R	
Ramo-Wooldridge Corporation, The	505
Raymond International, Inc.	533
Reidy, Maurice A.	535
Research-Cottrell, Inc.	447
Revere Copper and Brass, Inc.	503
Richard Company, Inc., Arklay S.	510
Rock of Ages	533
Ross Engineering Division, J. O.	439

(*Concluded on page 452*)

. . . CONCERNING YOUR PLASTICS PROGENY

The care and feeding of unruly high polymer molecules has been our day-in and day-out effort for many years now, and we are no longer perturbed to act as guardian and god-father to a plastics offspring. In such an event we are prepared to study its heritage and background, place it in a favorable environment, shield it in its infancy, forebear its adolescence, train and educate it in the best accepted traditions and guide it into adulthood so that it can take its place in the plastics family as a member of whom any parent can be justly proud.

We are also concerned with guiding your plastics progeny through the intricacies and pit-falls of their commercial life, and we stand by to suggest where they should live, the people with whom they should associate and what they should do for a living. And we are not above encouraging a timely marriage or suggesting or even helping with the conception of a line of grandchildren.

Along with the administering of other peoples off-spring, we are bringing up several of our own. One is called D & R Pilot Plants, Inc., and it is very nimble and adept at producing small amounts of plastic chemicals, monomers, polymers or products which ordinarily are too laborious for laboratory equipment and too small for production facilities. Another is D & R Plastic Welders, Inc., which is devoted to the production and sale of welding equipment for plastics and also to fabrication of plastic articles, particularly in the area of welding and tube bending.

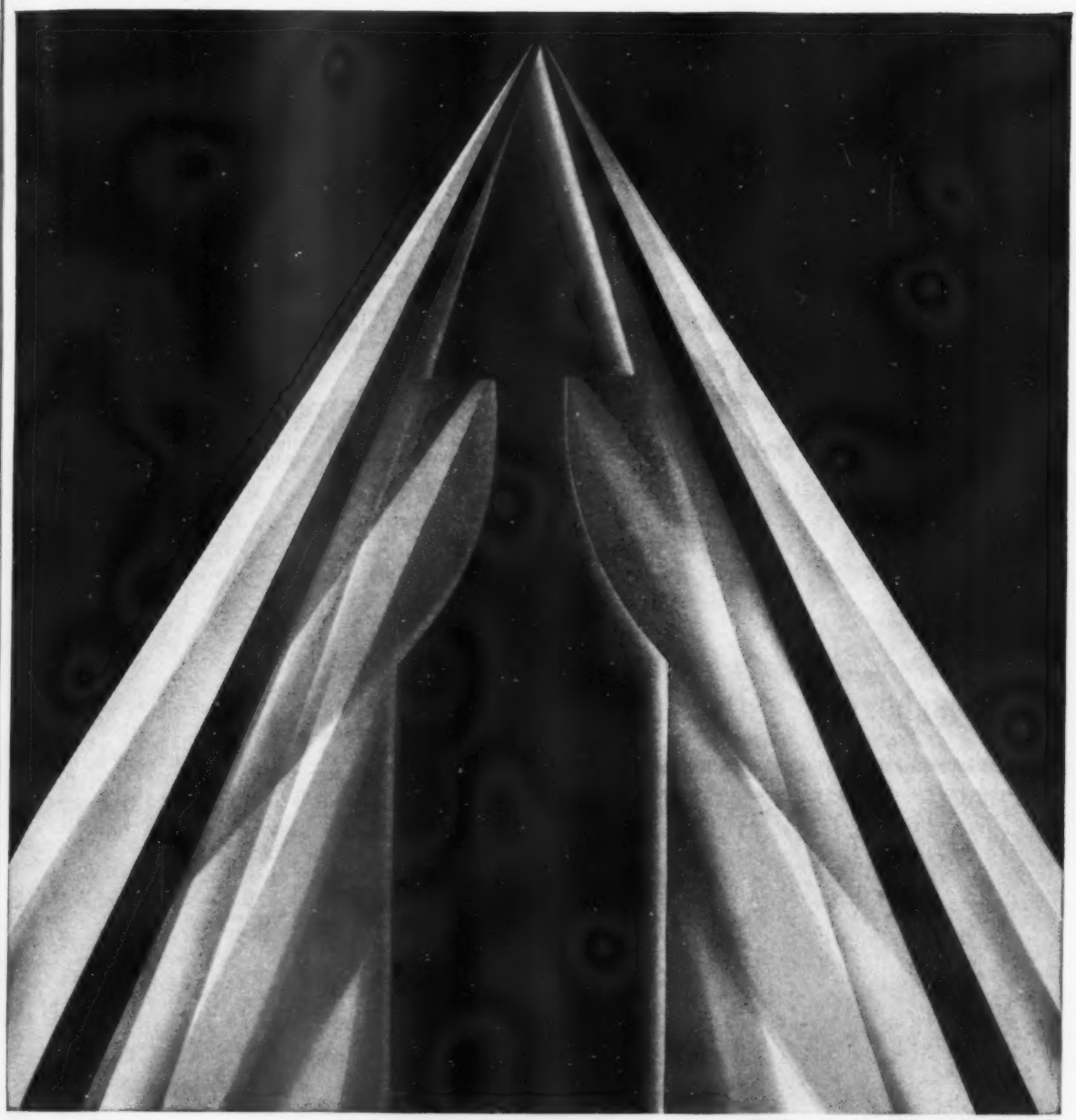
When you need a polypediatrician, ask us for further information on how we might lend to the procreation, care and upbringing of your family of products. This need not involve a proposition of 4 years at boarding school — we very frequently are called on just to blow noses.

DEBELL & RICHARDSON, INC.
Hazardville, Connecticut

John M. DeBell X-A '17
H. M. Richardson B.S. (E.E.)
U. of Colorado '25

F. D. DeBell X '44
S. B. King V '47

R. S. DeBell IX '48
XV '49
J. E. Curtis X '50



Shock wave around a simulated missile

SUPERALLOYS for supersonic performance

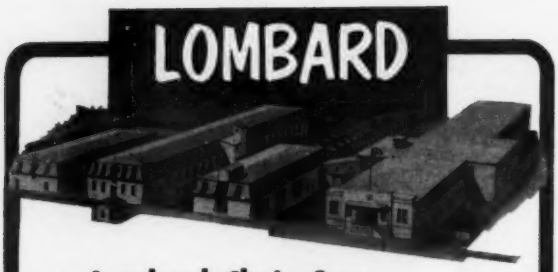
We develop them. And through modern vacuum melting produce them to the closest possible limits of chemical control and uniformity of mechanical properties for use in such critical components as aircraft turbine blades, buckets and skin material for missiles and rockets. UDIMET 500, one of our well established vacuum melted alloys, combines unsurpassed stress-rupture life with excellent ductility and fatigue strength in the 1200°F to 1800°F range. At 1200°F, for example, its tensile strength is 180,000 psi —at 1600°F, 100,000 psi. For further information concerning applications of these superalloys to your products, write to address below.

VACUUM MELTING
provides these properties

- *High temperature corrosion resistance*
- *Increased ductility*
- *Extreme cleanliness*
- *Precise chemical control*
- *Longer stress-rupture life*
- *Increased tensile strength*
- *Better fatigue resistance*
- *Greater yield strength*
- *Greater impact resistance*
- *Greater creep properties*

UTICA METALS DIVISION OF KELSEY-HAYES

UTICA DROP FORGE & TOOL DIVISION — KELSEY-HAYES CO., UTICA 4, NEW YORK



- Lombard Chain Saws
- Builders of Special Machinery
- Contract Machining Service
- Injection Molding Machines
- Hydro-Electric Governors

M. I. Woythaler '15 . . . . . *President*
R. H. Sawyer '17 . . . *Works Manager*
I. B. Dodge '98 . . . *Governor Engineer*

LG

LOMBARD GOVERNOR, CORP.
ASHLAND, MASS.

INDEX TO ADVERTISERS

(*Concluded from page 450*)

Advertiser	*Page*
S	
Sangamo Electric Company	530
Scientific Design Company, Inc.	441
Scully Signal Company	522
Second Bank-State Street Trust Company	449
Sentry Company, The	530
Simplex Wire and Cable Company ..... Inside Front Cover	
Singer Manufacturing Company, The	442
Smoley and Sons, Inc., C. K.	518
Sperry Gyroscope Company	436
Sprague and Henwood, Inc.	520
Standard Oil Company (Indiana)	525
Stevens-Arnold, Inc.	515
Syska and Hennessy, Inc.	534
T	
Taylor and Sons, Thomas	531
Technology Press, The	524
Times Facsimile Corporation	437
Tredennick-Billings Company, The	527
U	
Uhde Corporation, The	445
Underwood Corporation	513
Utica Metals Division of Kelsey-Hayes	451
V	
Vulcan-Cincinnati, Inc	511
W	
Westinghouse Electric Corporation	517
Wheeler Construction Company	525
Whirlpool Corporation	457
Wind Turbine Company, The	512
Wolfe Company, A. J.	532
Wyle Associates	532

PLANT No5

FURNACE BUILDING

•

LEHR BUILDING

•

WAREHOUSE

•

BATCHING PLANT

•

BUILT BY

BROCKWAY GLASS CO., INC.
FREEHOLD, N.J.

THE NICHOLSON CO.
BULK STORAGE · ENGINEERING · HANDLING EQUIPMENT · CONSTRUCTION
EDWARD WININGER '24 PRESIDENT

10 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.

The Blade of Damascus

In the dazzling, romantic days of the Three Musketeers, the name, "Damascus," symbolized the finest tempered steel. Today the blade of Damascus has taken on a more specific significance. It symbolizes the finest welded stainless steel tubing.

William B. Klee, Jr., '33, President

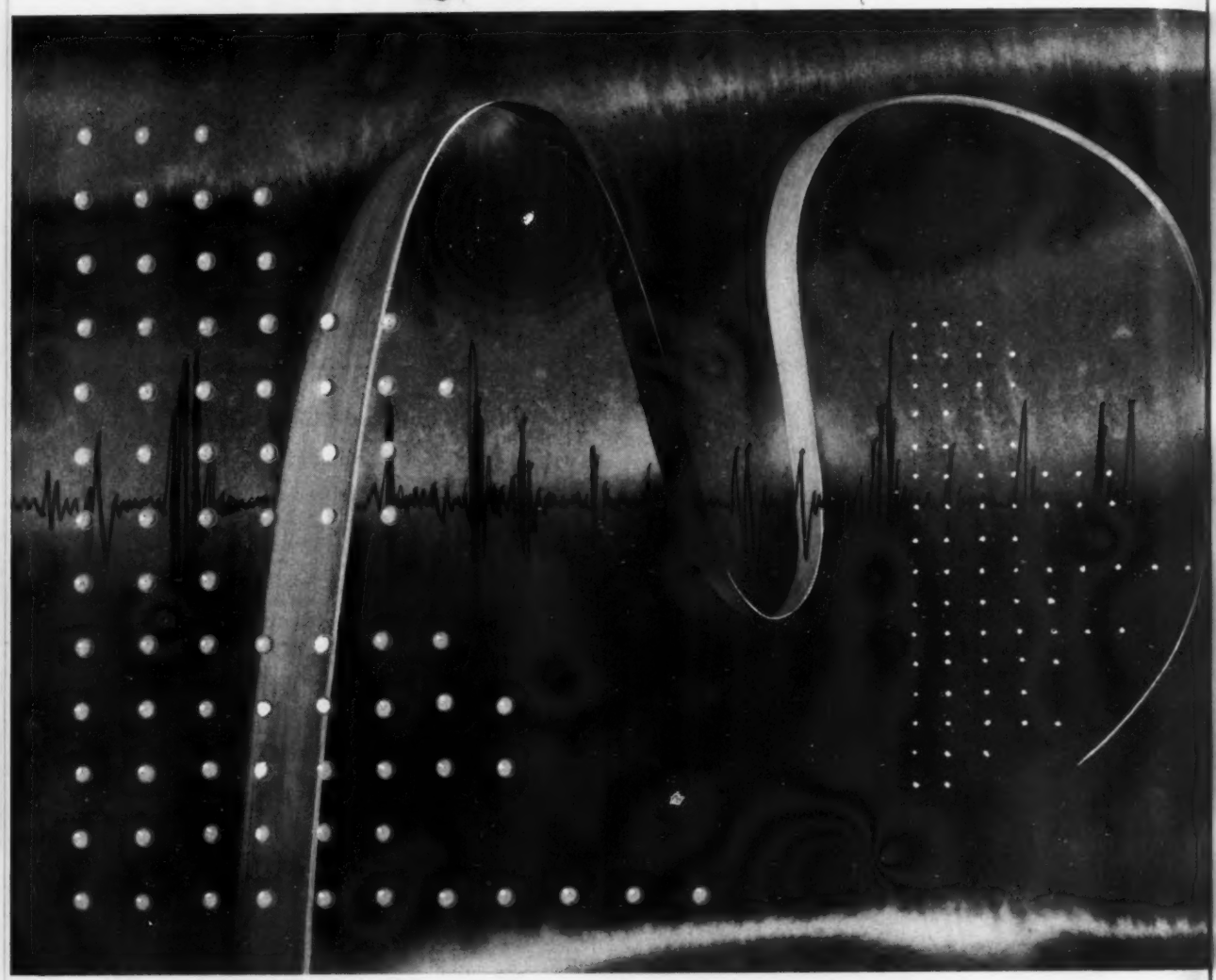
FORMED STEEL TUBE INSTITUTE

AMERICAN STEEL WAREHOUSE ASS'N

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA



Analysis of speech

The Speech Recognition Project at the IBM Yorktown Research Center has recently completed equipment able to convert speech into digital form for computer input. Information Research engineers and scientists cooperated on the project.

Two devices, an *Editor* and a *Coder*, are used to prepare speech samples for computer analysis. The *Editor* aids selection of "speech events" from continuous speech. In this operation edit pulses are written on a second track of an audio tape opposite speech events desired. The second device, a *Coder*, plays back the audio portion of edited tape through equalizer, compressor, and low-pass filter components to an analog to digital converter. As instructed by edit pulses, the converter samples speech signal amplitude and converts amplitude at each sample point to a six-point binary number. Simultaneously, the edit pulse also causes control circuits to bring the computer system tape unit up to speed and writes the converted signal on digital tape. Data thus stored on digital tape is then subject to a versatile system of analysis programmed on the computer.

The project is concerned with the question, "What properties do acoustic signals possess which aid in distinguishing speech sounds one from another?" It is hoped that this research will lead to the development of useful and natural systems for verbal control of machines.

IBM RESEARCH

Investigate the many career opportunities available in exciting new fields at IBM.

International Business Machines Corporation, Dept. 868S, 590 Madison Avenue, New York 22, New York

Centralized Control of Air Conditioning Saves Manpower, Assures Ideal Working Environment

Manpower savings of at least three men per day, reduced fuel and power consumption, longer equipment life and 24-hour-a-day comfort are made possible by this Johnson Control Center at North American Aviation's busy new headquarters at Los Angeles!

From the Center, *one man* operates all the basic heating, cooling and air handling components of a modern high pressure, double duct air conditioning system.

To aid him, all vital operating data needed to keep the system functioning at peak efficiency are transmitted to the panel from remote locations throughout the windowless, three-story building. Simply by scanning the panel or pushing a button, the engineer can check fan operations, temperatures, pressures and related data from well over 100 key control points!

Johnson Control Centers are applied to buildings of all types and sizes. They assure the very best, most productive working environment air conditioning can produce. And major savings in operating costs and manpower quickly recover the initial investment. Your local Johnson representative has all the facts. Johnson Service Company, Milwaukee 1, Wisconsin. 105 Direct Branch Offices.

The engineering, installation and sales of modern control centers, such as the above, are typical examples of the interesting and challenging work done by the specialist Johnson organization. M.I.T. alumni at Johnson include:

J. H. Colby, '35, Vice President & General Sales Manager, Milwaukee
F. W. Conlon, '50, Sales Engineer, Union, N. J.
E. C. Doyle, '47, Branch Manager, Albany, N. Y.
K. L. Holmes, '51, Research & Development, Milwaukee
W. G. Martin, '45, Branch Manager, Hartford, Conn.
K. A. Wright, '19, Vice President & Central District Manager, Evanston, Ill.

JOHNSON CONTROL
PNEUMATIC SYSTEMS
DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

TEMPERATURE CONTROL SYSTEMS FOR SCHOOLS, OFFICES, FACTORIES, STORES, HOSPITALS, HOTELS, PUBLIC BUILDINGS

Quality
Craftsmanship
in waterproof
and canvas footwear
for over 50 years

HUNTING

No-Bite Pac
Has patented comfort features every hunter appreciates

FISHING

Rod & Reel Boot
Universally preferred — designed by sportsmen for sportsmen

COLD WEATHER COMFORT

Anti-Freeze Pac
Insulated to insure warm feet in the coldest weather

BASKETBALL

All Star
The most popular basketball shoe in the world

CASUALS

Idlees
Cool, colorful footwear for all the family

CONVERSE 50th YEAR 1908 1958

CONVERSE

L. P. SANBORN '17 • A. H. WECHSLER '21
F. L. HALL '25 • R. E. GLADSTONE '40

CONVERSE RUBBER COMPANY
MALDEN 48, MASSACHUSETTS

Chicago Branch: 2000 Mannheim Road, Melrose Park, Ill. • 100 Freeway Blvd., So. San Francisco • 241 Church St., New York 13, N. Y.

AT Whirlpool

the people grow too!

Research and Development grew 13 times

Sales grew 17 times

Plant and Equipment grew 35 times

Product lines grew 7 times

Number of personnel grew 8 times

from 1948 through 1957

The growth of this company was planned. It came as the result of a forward looking approach to the business of staying in business. It is the result of the concerted efforts of all of those who are now or who have been members of this organization. It is the result of the attitude which is expressed by chairman of the board Elisha Gray II in his statement that " . . . the ultimate success of this company depends on your willingness to use your best abilities to do a little bit better job than has been done before."

To meet this challenge with initiative and enthusiasm is the goal of our people . . . it is their growth which is the cornerstone and the future of Whirlpool.

ELISHA GRAY II, '28
Chairman

Whirlpool

CORPORATION

St. Joseph, Michigan

Vought engineer... key figure in a changing world

He is the man who puts wings on ideas. Through his inventive genius, America is able to maintain peace through preparedness in a complex nuclear age.

He is the man who points the way to tomorrow. His bold approach to the science of flight and to the problems of engineering will bring a better future to all America.

He created the mighty deterrent power of the submarine-based *Regulus II* and the *Crusader* manned fighter series for near-space. Today, he again is advancing our farthest thinking . . . for the upper atmosphere . . . for space. He is working to keep our security *constant* in a changing world.

For a current report on Vought activities, future plans, write: C. A. Besio, Supervisor, Engineering Personnel, Dept. TR-1.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

The Explorer Satellites
record their data from Space on
FITCHBURG Facsimile Paper!

The top sheet in the illustration at the left is an Associated Press illustrated release. The bottom sheet represents recorded data sent from the U. S. Army Explorer I Satellite.

BECAUSE it can reproduce continuously, **FITCHBURG FACSIMILE PAPER** is being used to record graphically the data this country's Explorer Satellites are sending from Space. The Associated Press, the United Press, and the U. S. Government are the chief outlets for this type of communication, linked to more than 700 receiving stations. Obviously, many of the uses are classified.

FITCHBURG FACSIMILE PAPER reproduces electronically, not photographically. This remarkable industrial specialty paper actually reproduces the image from electrical impulses received from the sending station. Developed in our Research Laboratories, **FITCHBURG FACSIMILE PAPER** is notably whiter, cleaner, smoother, with uniform caliper assured by nuclear controls. Only highly purified pulp is used to make it, under the most stringent standards of cleanliness and quality control.

The 97 year old Fitchburg Paper Company is headed by George Rodney Wallace '13, president and chairman of the board, and the third generation in ownership. The company manufactures industrial specialty papers such as Photographic Papers, Direct Reproduction Papers, Facsimile Papers and Plastic Laminating Papers. Also manufactured are fine papers for printing, such as greeting card stock and offset papers.

IF paper is part of your manufacturing picture, or if you have a paper problem, you are invited to consult the company without obligation.

INDUSTRIAL SPECIALTY PAPERS

Photographic Papers
Direct Reproduction Papers
Facsimile Papers
Plastic Laminating Papers

FINE PAPERS FOR PRINTING

Greeting Card Papers
Offset Papers

Established in 1861

Fitchburg Paper Company *Buy Direct from the Mill*

MILLS AND GENERAL OFFICE: FITCHBURG 6, MASS., NEW YORK OFFICE: 250 PARK AVE., N. Y. 17

WANT ENGINEERING'S HOTTEST ADVANCES?

Bold New Car for a Bold New Generation

GET THE FACTS AND YOU'LL GET A PONTIAC!

Your first mile will be a real eye opener—the industry's hottest new team of engineers sparked this bold new creation with a totally new type of action! You'll experience jeweled-action response from Pontiac's great new Tempest 395 engine . . . a power plant built to tolerances finer than the finest watch! You'll discover all-new comfort, thanks to a revolutionary new chassis design which conquers dive, sway and bounce to a degree never before possible . . . and an effortless preciseness of handling that's nothing short of magic! In every way, this high-stepping beauty will put fresh new excitement into your kind of driving! Come in soon—for today's biggest money's worth!

PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION

BIG BOLD *Chieftain* PONTIAC

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Co., Inc.

Here at Douglas we're involved in a greatly accelerated missile and space program. This requires one of the most intensive engineering and research efforts in our history.

The problems are great ones as we move into the new dimension of unmanned and manned space vehicles. They require specialists in almost every engineering field. But their solution will result in great benefits not only to our own nation but to all mankind.

If you're interested in tackling these problems with us... in giving your best in an all-out drive to solve them... we're interested in you!

Please write to Mr. C. C. La Vene
Douglas Aircraft Company, Box 620-N
Santa Monica, California

GOODYEAR

for its Sixtieth Anniversary Year proudly presents

The New *Double Eagle*

☆ NEW DIAMOND JUBILEE TIRE ☆

This new Double Eagle culminates 60 years of continuous research and development. It is *the finest tire men can make or money can buy.*

Beneath the road-gripping tread is incredible strength . . . strength that provides far more safety.

This you can credit to Goodyear's exclusive 3-T process which triple-tempers the Double Eagle's Nylon Cord under precisely controlled Tension, Temperature and Time.

A revolutionary pre-shaping technique prepares this custom-crafted tire for greatly increased mileage.

To this you can add the comfort that comes with soothing quietness—the security you sense from increased traction and nonskid protection—the satisfaction of better all-around high-speed performance.

Marked by the *blue circle of safety*, this superlative tire can be equipped with Goodyear's new Captive-Air Steel-Cord Safety Shield for new freedom from worry over blowouts, punctures, or roadside tire changes.

See this remarkable Double Eagle at your nearby Goodyear dealer's. Goodyear, Akron 16, Ohio.

MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER KIND!

Captive-Air, Double Eagle, T. M.'s, The Goodyear Tire & Rubber Company, Akron, Ohio

THE TECHNOLOGY REVIEW

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS for JULY, 1958, Vol. 60, No. 9

ALUMNI SOCIABILITY — Front Cover

MAINTAINING OUR TECHNOLOGICAL STRENGTH — Frontispiece 464

ZEST FOR LIVING — By Harold L. Hazen 471
Baccalaureate sermon emphasizes role of intellectual awareness and curiosity in building an interesting life

OBLIGATIONS OF THE SCIENTIST — By John J. McCloy 475
Training in scientific disciplines provides unusual opportunity to take active part in the world's work is theme of commencement address

MAINTAINING THE STRENGTH OF U. S. TECHNOLOGY — By James R. Killian, Jr. 479
Today's exacting demands call for more engineers nurtured in an atmosphere of scientific research

REPORT OF THE INSTITUTE — By J. A. Stratton 482
Annual report to Alumni stresses need for understanding the complex interrelations between society and technology

SOVIET EDUCATION — A LESSON FOR AMERICA — By Morris Cohen 483
We need to build an educational system that demands first-class intellectual effort from the masses of students in our schools

RESEARCH IN UNDERGRADUATE ENGINEERING EDUCATION — By Edwin R. Gilliland 489
Stronger programs for engineering education are under study at the Institute as engineering becomes more scientific

ASTRONAUTICS — A CHALLENGE IN ENGINEERING EDUCATION — By Holt Ashley 491
Courses in Aeronautical Engineering capitalize on the students' natural motivations and enthusiasms

REUNION IN CAMBRIDGE — A Technology Review Report 495
A comprehensive review of the events of commencement and Alumni Day is presented for the record

THE TABULAR VIEW — 444
Contributors and contributions to this issue

THE TREND OF AFFAIRS — 465
Relating to the Massachusetts Institute of Technology

It's windy on the mall for those taking part in the Alumni Day social hour.

This photograph, as well as all others in the issue, by M.I.T. Photographic Service.

EDITOR:
B. Dudley

BUSINESS MANAGER:
R. T. Jope

CIRCULATION MANAGER:
D. P. Severance

EDITORIAL ASSOCIATES:
Paul Cohen
J. R. Killian, Jr.
F. W. Nordsiek
J. J. Rowlands

EDITORIAL STAFF:
Ruth King
Shirley G. Reese
Winifred R. Sibley

BUSINESS STAFF:
Madeline R. McCormick
Catherine MacLachlan

PUBLISHER:
H. E. Lobdell

Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 60 cents a copy. Annual subscription, $4.00; Canadian and foreign subscription, $4.50. Published for the Alumni Association of the M.I.T.; Gilbert M. Roddy, President; H. E. Lobdell, Executive Vice-president; John J. Wilson, D. Reid Weedon, Jr., Vice-presidents; Donald P. Severance, Secretary-Treasurer. Published at Hildreth Press, Inc., Bristol, Conn. Editorial Office, Room 1-281, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the Post Office at Bristol, Conn. Copyrighted, 1958, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect change of address, for which both old and new addresses should be given.

An attentive audience listens to Alumni Day address delivered by Dr. Killian, Special Assistant to President Eisenhower for Science and Technology (standing at microphone). Those at head table are (left to right): Robert E. Jordan, 3d, '58, Mrs. Gilliland, Mrs. Skinner, Professor Edwin R. Gilliland, '33, Mrs. Jordan (partly hidden by tent pole), Mrs. Roddy, David W. Skinner, '23, Mrs. Karl T. Compton, Gilbert M. Roddy, '31, Mrs. Stratton, Dr. Killian, Saxton W. Fletcher, '18, Mrs. Killian, Acting President J. A. Stratton, '23, Mrs. Lobdell, H. Leston Carter, '08, Mrs. Fletcher, H. E. Lobdell, '17. Beyond the scope of the present view were also: Mrs. Ashley, Professor Morris Cohen, '33, Mrs. Cohen, and Professor Holt Ashley, '48. Portion of audience shown here are honored guests.

The Technology Review

VOL. 60, NO. 9 JULY, 1958

The Trend of Affairs

Tech Sailors Are National Champions

■ William S. Widnall, '59, of Saddle River, N.J., led the M.I.T. sailors to a victory over seven rival finalists in the 22d sailing of the North American Intercollegiate Dinghy Championship. This competition for the Henry A. Morss Memorial Trophy was held at Newport Harbor, Calif., June 16 to 20.

Widnall compiled an individual B division score of 131 points out of a possible 144 in the 32-race event. Captain C. Dennis Posey, '59, of Larchmont, N.Y., scored 98 points in A division, giving the M.I.T. sailors a total of 229 points to 213 points for the University of Michigan. The Michigan sailors, led by A division skipper Bruce Goldsmith, took a small early lead in the races. They held their lead until the 25th race, when the Tech sailors went into first place to coast to victory. Bill Widnall's score included 10 firsts, 3 seconds, 2 thirds, and a sixth in his 16 races.

The other colleges, in order of finish, were: defender, the U. S. Naval Academy, 203; Notre Dame, 179; Brown, 170; Occidental, 164; Stamford, 156; and the U. S. Merchant Marine Academy, 108.

In the preliminary team championships between the four districts of the Intercollegiate Yacht Racing Association, Midwest defenders Michigan and Notre Dame scored a close victory over M.I.T. and Brown (representing New England) to retain possession of the Sir Thomas Lipton Memorial Trophy. The Midwest took an early 2-0 lead, which the New England teams tied at 2-2. The Midwest then took the next race by three-fourths of a point and the last by a more comfortable margin when Widnall failed to hear a recall hail for being early at the start.

The National Championship was a fitting climax to a successful year, which saw the team victorious in 12 of the 21 events in which they competed. The Tech team is also holder of the Eastern, New England, and Boston area championships. M.I.T. has won the Morss Trophy 10 times in the last 22 years, has been in second place three times, in third place twice, and in fourth place three times.

Members of the M.I.T. Nautical Association include C. Dennis Posey, '59, William S. Widnall, '59, Robert S. Hopkins, Jr., '60, Carol M. Dorworth, '60, and Jan A. Northby, '59.

Oscar Hedlund Retires

■ Track coach at M.I.T. since 1924, Oscar F. Hedlund retired July 1 from a post in which he has won thousands of warm friends. The announcement was made at a testimonial dinner held at the Faculty Club on the evening of May 2, and ends an active 35-year career of service to M.I.T. students.

The past and present track men who gathered to fete Coach Hedlund were joined by Acting President J. A. Stratton, '23, Ralph T. Jope, '28 (who played a significant role in managing athletic activities before a full-time athletic director was added to the Institute staff), and many other members of the Faculty and Administration. Approximately 150 attended the dinner, and more than 250 track men of former years wrote letters expressing their appreciation of Oscar's coaching, friendly advice, and personal interest.

A plaque, unveiled at the dinner by Richard L. Balch, Director of Athletics, recognizes Oscar Hedlund's influence on the Institute's athletic program, and will be placed in the Du Pont Athletic Center when construction on the new buildings is completed. The plaque reads:

Oscar F. Hedlund

As a friend to each man he encouraged the full development of character and athletic potential. By giving so much of himself he has set a standard of coaching excellence for M.I.T. athletics and won a place of affection in the heart of every track man.

Although known and highly regarded mainly for his work in track and cross-country coaching during the past 35 years, Hedlund himself was a star runner in former years. He is former world's champion in the mile run, and was a member of the American Olympic team in 1912. In recognition of his great interest in sports, the New England Olympians elected him to be their new president.

On May 28, 1956, Mr. Hedlund was elected an honorary member of the M.I.T. Alumni Association, and he was inducted into this select group at Alumni Day events on June 11, 1956, as recorded on page 491 of the July, 1956, issue of The Review.

As recorded below and on the opposite page, the three Institute Faculty members shown above are to assume new duties — Roy Lamson (left), *as professor of humanities; Howard R. Bartlett* (center), *as master of Burton House; and Joseph H. Keenan, '22* (right), *as head of the Department of Mechanical Engineering.*

Pointed Appointments

■ E. P. Brooks, '17, Dean of the Institute's School of Industrial Management, has announced the appointment of Howard W. Johnson as Associate Dean of the School, effective July 1.

Mr. Johnson has been associate professor of industrial management and director of the Executive Development Program at M.I.T. since 1955. He has been responsible for the administration of the Sloan Fellowship Program, which brings 36 of the country's outstanding young executives to M.I.T. each year to work for a master's degree, and provides for two 10-week sessions each year for senior executives who wish to broaden their understanding of decision-making and the environment of business.

Professor Johnson received his A.B. degree in economics, with honors, from Central College in Illinois, and his M.A. degree from the University of Chicago. He has also done graduate work at Indiana University and the University of Glasgow in Scotland. Before coming to M.I.T. he was assistant professor of industrial relations and director of management programs in the Industrial Relations Center at the University of Chicago; assistant director of personnel administration for General Mills, Inc.; and a member of the staff of Robert N. McMurry and Company, management consultants, in Chicago.

John E. Burchard, '23, Dean of the Institute's School of Humanities and Social Studies, announced that Roy Lamson, former Professor of English and Dean of Freshmen at Williams College, has been appointed professor of humanities at the Institute. Dr. Lamson has been at M.I.T. as a visiting professor for the past year.

After attending Cambridge High and Latin School, Professor Lamson received A.B., A.M., and Ph.D. degrees from Harvard University and was an instructor at Harvard for three years. He joined the staff of Williams College in 1938. During World War II he served in the War Department Bureau of Public Relations and later in the Historical Division, being assigned to Italy and then France and Germany. He left Williams College again in 1951 to serve for nearly three years as historian of Supreme Headquarters Allied Powers in Europe.

As a scholar Dr. Lamson's special interest is in the English Renaissance, and he has written extensively on ballads and Seventeenth Century music.

Keenan Heads Course II

■ Appointment of Joseph H. Keenan, '22, as Head of the Department of Mechanical Engineering at the Institute, was announced early in June by Julius A. Stratton, '23, Acting President. Professor Keenan succeeds Professor Jacob P. Den Hartog, who has served with distinction in this post since 1954 and who will now return, at his own request, to full-time teaching and research.

Professor Keenan was graduated from M.I.T. with a degree in Naval Architecture in 1922. He was a turbine design engineer for the General Electric Company in Schenectady, N.Y. from 1922 to 1928, and from 1928 to 1934 was a member of the faculty at Stevens Institute of Technology. He returned to M.I.T. in 1934 as an associate professor of mechanical engineering. He has served the National Advisory Committee for Aeronautics in studies of such problems as propulsive systems, internal flow and recovery of power from exhaust gases, and has been a consultant to industry on new methods of aircraft propulsion and other problems of mechanical engineering.

Professor Keenan is a fellow of the American Society of Mechanical Engineers and has been secretary and chairman of the Applied Mechanics Division of that Society. He has served on five international committees on the properties of steam and is author of a number of books on thermodynamics and co-

author of "Thermodynamic Properties of Steam," a set of tables which has influenced design of modern equipment in the entire steam-power industry. He has served in England as a Fulbright Professor and as lecturer at both Imperial College of Science and Technology, and Cambridge University.

In 1955, the American Society of Mechanical Engineers awarded the Worcester Reed Warner Medal to him for "his outstanding contribution to the permanent engineering literature of steam, air and gases."

Professor Keenan is a fellow of the American Academy of Arts and Sciences, holds honorary membership in the Association of Physics Teachers, and is a member of the Institute of the Aeronautical Sciences, the American Society for Engineering Education, the American Society of University Professors, Tau Beta Pi, and Sigma Xi.

Professor Den Hartog, who was born in Java and was graduated from Delft Technical University in Holland, came to the United States in 1924 and joined the staff of the Westinghouse Electric and Manufacturing Company. He became a member of the faculty of Harvard University in 1932. During World War II he served in the Navy Bureau of Ships and, as an authority on vibrations, participated in the trials of practically every new type of ship. He assumed a professorship at M.I.T. in 1943 and became head of the Department of Mechanical Engineering in 1954.

Professor Den Hartog received the Worcester Reed Warner Medal in 1951 and last November gave the Thomas Hawksley Lecture in London, the first American ever to have been honored by an invitation to give the lecture.

Master of Burton House

■ Appointment of Howard R. Bartlett, Head of the Department of Humanities, as master of Burton House at the Institute was announced early in May by Julius A. Stratton, '23, Acting President. This is the first step in a plan by which all dormitories will have resident masters and tutors.

In 1951 the Institute inaugurated a system by which a "Faculty resident" was appointed to each house whose responsibility was that of counseling and guiding students. Under the new plan, a professor will be appointed as master of each house and the program of counseling and guidance will be extended. The master will be assisted by as many as two senior tutors, who will be junior members of the Faculty, and by several tutors, who are likely to be graduate students. Each house will also have nonresident associates – distinguished members of the Faculty who will be invited to participate in student affairs.

Appointment of the master and tutors for Burton House will be effective in the fall of 1958. The plan later will be extended to other houses. In announcing the new plan, Dr. Stratton said:

"We believe that an important part of education is the association between undergraduates and mature scholars. The new plan is the logical development from the beginning made seven years ago and should provide profitable new opportunities for students to share on an informal basis with Faculty members in the educational process. We hope that each house will develop its own character and tradition, making for a community spirit and a high level of personal achievement."

On the Horizon

November 8, 1958 – 13th M.I.T. Alumni Regional Conference, Albuquerque, N.M.

As master of Burton House, Professor Bartlett succeeds E. Neal Hartley, Associate Professor of History, who has been Faculty resident for the past two years. Professor Bartlett is head of the Department of Humanities and has taught English and history since he came to M.I.T. in 1929. He is a native of Auburn, Maine, and has degrees from Dartmouth College and Harvard University.

Last fall Professor Bartlett went to India as an American Specialist in the Leaders in Specialist Division, International Exchange Services, Department of State, consulting on general education in a project co-sponsored by the Indian Ministry of Education. For a month he was at the University of Roorkee, where he gave six lectures, and for a month he was at the University of Bombay, working with representatives of 16 affiliated colleges.

Professor Bartlett is former chairman of the Division of English and the Humanistic-Social Division of the American Society for Engineering Education.

William H. Lawrence: 1868-1958

■ Professor Emeritus William H. Lawrence, '91, former chairman of the Division of Drawing and the Architectural Engineering Course, and curator of the Lowell Institute, died on June 12. He was 89 years old.

Professor Lawrence had a long association with M.I.T., from the time of his graduation in 1891 until his retirement in 1938. Following graduation he became an instructor in architecture; in 1896 he was appointed an assistant professor, in 1901 associate professor, and in 1909 full professor. He served as chairman of the Department of Architecture from 1914–1919, and in 1920 was made chairman of the Division of Drawing. He became chairman also of the Architectural Engineering Course in 1927 and served in both capacities until his retirement in 1938, as professor of architectural engineering, emeritus.

He also had a long association with the Lowell Institute, as a Faculty member from 1912 to 1943 and as curator from 1921 to 1953. During the year 1924–1925, Professor Lawrence lectured on architectural construction at Harvard University. He was a fellow of the American Association for the Advancement of Science, and a member of the American Institute of Architects and of the Boston Society of Civil Engineers. He is author of the book *Principles of Architectural Perspective*, second edition, a textbook for a short but comprehensive course in perspective for scientific and technical schools.

Professor Lawrence is survived by his wife, Gertrude, and his brother, Ralph R. Lawrence, '95, who is professor of electrical machinery, emeritus.

Individuals Noteworthy

■ Prominent in the news since The Review's last issue were the 18 promotions, elections, or appointments enumerated below:

George M. Sprouls, '12, as Technical Director, American Rayon Institute, Inc. . . . *Walter J. Hamburger, '21,* as Vice-president, the Textile Institute, Edinburgh, Scotland . . . *Frederick S. Blackall, Jr., '22,* as a Director, National Shawmut Bank, Boston . . . *Roscoe H. Smith, '23,* as President, Cleveland Engineering Society, Cleveland, Ohio . . .

Walter E. Campbell, '26, as Vice-president, Boston Society of Architects . . . *John M. Gaines, '26,* as Associate Technical Director, Linde Company Division, Union Carbide Corporation . . . *Elisha Gray, '28,* as Chairman, Whirlpool Corporation . . .

Alexander L. H. Darragh, '29, as Executive Editor, *Transportation Supply News,* Chicago . . . *John C. King, Jr., '33,* and *Bruce A. Lamberton, '44,* respectively, as Manager of Sales and Chief Engineer, Intrusion-Prepakt, Inc., Cleveland, Ohio . . .

Frank R. Milliken, '34, as Executive Vice-president, Kennecott Copper Corporation . . . *Elmer J. Roth, '35,* as Comptroller, Whitin Machine Works, Whitinsville, Mass. . . . *Howard S. Turner, '36,* as a Director, Industrial Research Institute, Inc. . . .

William B. Bergen, '37, as a Director, The Martin Company, Baltimore, Md. . . . *Karl Pfister, 3d, '40,* as Executive Director of Developmental Research, Merck Sharp and Dohme Research Laboratories, Rahway, N.J. . . . *Roger E. Robertson, '41,* as Chief Engineer, B and H Instrument Company, Fort Worth, Texas . . .

James L. Knapp, '50, as Manager, Glass Technology Department, Corning Glass Works, Corning, N.Y. . . . *William C. Mercer, '56,* as General Plant Supervisor, New England Telephone and Telegraph Company.

■ Special honors recently announced or awarded to Alumni include:

To *Robert B. Sosman, '04,* the Trinks Award, highest honor of the industrial heating industry, by the Trinks Industrial Heating Award Committee . . . to *Warren K. Lewis, '05,* a Founders Award for achievements which have an extraordinary impact on Chemical Engineering, by the American Institute of Chemical Engineers . . .

To *Marshall B. Dalton, '15,* an honorary doctorate of engineering, by Worcester Polytechnic Institute . . . to *Herbert J. Gilkey, '16,* the Henry C. Turner Medal for "advancing the knowledge of properties of plain and reinforced concrete," by the American Concrete Institute . . .

To *C. Richard Soderberg, '20,* an honorary doctorate of science by Tufts University . . . to *Herbert L. Beckwith, '26,* the grade of Fellow, by the American Institute of Architects . . .

To *James R. Killian, Jr., '26,* honorary doctorates of science, by Columbia University and the College of Wooster, and of laws, by Brandeis University . . . to *Michael L. Radoslovich, '26,* its 1958 Medal for outstanding service in enhancing New York City's school buildings with murals and sculpture, by the Municipal Art Society . . .

To *Howard A. Chinn, '27,* the grade of Fellow, by the American Institute of Electrical Engineers . . . to *Edward D. Stone, '27,* membership, by the affiliated American Academy and National Institute of Arts and Letters . . .

To *Gordon S. Brown, '31,* an honorary doctorate of engineering, by Purdue University . . . to *Donald A. Rice, '32,* the Colbert Medal "for his important contributions to the Department of Defense," by the Society of American Military Engineers . . .

To *R. B. Woodward, '36,* the Theodore William Richards Medal, by the American Chemical Society . . . to *Elias Burstein, '43,* the Basic Science Award "for his pioneering work using infrared radiation to investigate the fundamental properties of semiconductors," by the Naval Research Laboratory Branch, Scientific Research Society of America . . .

To *Bruce P. Bogert, '44,* the Biennial Award for his "substantial contributions," by the Acoustical Society of America . . . to *William D. Kingery, '48,* the John Jeppson Medal for "distinguished service," by the American Ceramic Society . . .

To *Walter J. K. Tannenberg, '52,* and *Jerome D. Waye, '54,* honors for "diligent work and qualities serving to designate a good physician," by the Massachusetts Medical Society.

Creole Foundation Grant

■ Announcement was made in the spring by J. A. Stratton, '23, Acting President, that the Institute had received a grant of $30,000 from the Creole Foundation of Caracas, Venezuela, to aid M.I.T.'s program of research and education in soil engineering.

The grant is the first the Creole Foundation has made in New England and the largest it has ever given to an educational institution in the United States. The money will be used to expand facilities in the M.I.T. soil engineering laboratories in the Department of Civil and Sanitary Engineering.

Soil engineering deals with the fundamental properties of soils and with ways of improving them for engineering purposes. It ranges from foundation studies for buildings and bridges to research on highway and airport construction, as well as on such earth structures as dams, embankments, and tunnels. The first course in soil engineering in the United States was given at M.I.T. in 1928.

Soil engineers from underdeveloped countries — some of whom are studying at M.I.T. — are particularly interested in the use of earth as a building material. In many of these countries, soil is not only the most economical but also the only available construction material.

More than 125 Latin American students, including 16 from Venezuela, are currently enrolled at M.I.T. Several of these students are doing pioneering research on new ways of using soil in engineering projects in their homelands.

The Creole Foundation was organized in 1956 by the Creole Petroleum Corporation, which is a United States company operating in Venezuela and one of the world's major oil producers. The Foundation contributes to educational, scientific, and cultural progress in Venezuela and to related activities in the United States.

Lowell Institute Commencement

■ Certificates and diplomas were awarded to more than 100 students of the Lowell Institute School at graduation exercises held in Huntington Hall of M.I.T. at 8:30 P.M. on May 22.

Principal speaker at the ceremonies was Edward E. Booher, Executive Vice-president of the McGraw-Hill Book Company. He shared the platform with Professor John B. Wilbur, '26, Head of the Institute's Department of Civil and Sanitary Engineering, who spoke on behalf of M.I.T., and Ralph Lowell, trustee of the Lowell Institute School, who awarded the certificates. Professor Arthur L. Townsend, '13, Director of the School, presided.

A feature of the evening was the 13th award of the Charles Francis Park Medal to Gerald J. Bradley, the year's outstanding student. Bradley, winner of the Park Medal, attended Chelsea High School, and for the past five years has served as inspector of naval material at the Boston Naval Shipyard.

Mr. Booher, speaker at the exercises, is widely known for contributions to educational book publishing. He has been with the McGraw-Hill Book Company since 1936, is a trustee of Antioch and Pace Colleges, vice-president of the New York Academy of Public Education, and director of the American Institute of Graphic Arts and the American Textbook Publishers Institute.

In his talk before the graduates, Mr. Booher related recent experiences he had encountered this spring in a visit to Russia, and compared technical education in the Soviet Union with that to be found in the United States. He also paid special tribute to Professor Townsend, who received the 8th annual James H. McGraw Award in Technical Institute Education a year ago.

In recognizing and congratulating the graduates on achieving a worth-while program of study under the difficult circumstances of going to classes several evenings a week after completing a full day's work, Professor Wilbur made a strong plea for strengthening engineering education. Said Professor Wilbur:

> The engineer must, of a certainty, have a firm grounding in science; but in professional practice, such knowledge is but a springboard for most of the situations he will encounter. He must operate in areas that are in part above and beyond the well-documented but relatively limited areas of systematized knowledge. Perhaps the principal function of the truly professional engineer is to harmonize and relate the conflicting forces and tendencies that — unlike the situations encountered in pure science — are bound to be present when one attempts to apply science to the welfare of society. Such a process of harmonizing and relating is not a science, but is an art in the highest sense; and if this art should be crowded out by science to the point where it is virtually nonexistent, then the very essence of professionalism in engineering would likewise be lost in the bargain.

The Lowell Institute School, conducted under auspices of the Institute, gives two-year, tuition-free curricula in the fundamentals of mechanical, electrical, and structural engineering, and a number of single subjects in other technical fields.

Grant for Chair in Physical Science

■ Precedent-setting grants totaling $2,500,000 for professorial endowments at five eastern universities — Harvard, Yale, Princeton, the University of Pennsylvania, and the Institute — were announced on May 22 by the Donner Foundation of Philadelphia, one of the country's largest philanthropic foundations.

Announcement of the grants, amounting to $500,000 to each of the five educational institutions and payable over a five-year period, was made by Robert A. Maes, Executive Vice-president of the Donner Foundation. The money is to be used to endow a Donner Chair of Science at each of the universities. Income from the grants will provide a yearly salary to the person selected to fill the position created at each of the universities.

The Donner Chairs will be among the nation's most highly endowed university chairs, and this grant represents one of the few occasions when foundation funds have been awarded for endowed chairs, rather than for buildings, equipment, scholarships, or projects. In making the grant, Mr. Maes said:

> The Donner Foundation considered this step for some time before acting on the grants. In an age when scientific education is of utmost importance, the board of directors of the Foundation felt that this would be the wisest course of action.
>
> The Foundation hopes that these will be the forerunner of similar grants by other individuals and organizations interested in maintaining and improving the economic status of the teaching profession.

In accepting the grant on behalf of M.I.T., J. A. Stratton, '23, Acting President, said:

> The destiny of civilization may well rest upon the future creativeness of science and technology. Scientists and engineers have already achieved the physical means to conquer space, new ways of preventing and healing diseases, new tools for a longer and more comfortable life, as well as a host of other accomplishments. Yet we as a nation have failed, as President Eisenhower has said, "to give high priority enough to science education and to the place of science in our national life."
>
> It is for this reason that I particularly welcome the generous action by the Donner Foundation, establishing an endowed professorship in the physical sciences to be known as the Donner Chair of Science. . . .

The Donner Foundation was founded in 1932 by the late William H. Donner, President of the Donner Steel Company of Buffalo, N. Y., until its sale to Republic Steel Corporation in 1929, in memory of his son, Joseph, who died of cancer on November 8, 1929, at the age of 35. Named the International Cancer Research Foundation first, the organization was renamed the Donner Foundation in 1945.

Since 1949, the Donner Foundation has channeled the majority of its grants into three fields — awards to recognized and reputable groups or institutions for research on the cause of and cure for the less understood illnesses and diseases, a scholarship program in aid of secondary education, and support of projects designed to preserve the American way of life. From its inception to date, the Foundation has granted awards totaling almost $6,250,000.

Twenty-five Years Ago This Month . . .

■ On July 1, 1933, Dr. Allan Winter Rowe, '01, Chief of Research Service of the Evans Memorial of the Massachusetts Memorial Hospitals, retired as the 39th President of the Alumni Association, being succeeded in that office by Redfield Proctor, '02, President of the Vermont Marble Company, a Life Member of the Institute Corporation, and in 1923–1925, Governor of the State of Vermont.

Other retiring officers of the Rowe Administration of 1932–1933 were: W. Malcolm Corse, '99, as Vice-president; William H. Coburn, '11, and Harold S. Wilkins, '14, as members of the Executive Committee. Their respective successors in the Proctor Administration of 1933–1934 became: Edward L. Moreland, '07, Grosvenor D. Marcy, '05, and Charles E. Smith, '00.

[Two of the above-named subsequently served as Presidents of the Alumni Association, namely: Smith, 41st President in 1934–1935, and Moreland, 42d in 1935–1936.]

. . . William S. Forbes, '93, Lammot du Pont, '01, and Frank B. Jewett, '03, retired as Alumni Term Members of the Institute Corporation, being succeeded by Allan Winter Rowe, '01, Louis S. Cates, '02, and H. B. Richmond, '14.

[Later, four of the above-named were elected Life Members of the Corporation, namely: Du Pont and Jewett in 1934, Cates in 1943, and Richmond in 1952.]

. . . Nine long-time members of the Faculty, whose combined length of service to M.I.T. totaled 352 years, retired on June 30, 1933. Two of these were Heads of Departments: David R. Dewey and Waldemar Lindgren, respectively, of Economics and Geology. Six were Professors: Robert P. Bigelow, of Zoology and Parasitology; W. Felton Brown, of Freehand Drawing; William Hovgaard, of Naval Design and Construction; William A. Johnston, '92, of Theoretical and Applied Mechanics; Ervin Kenison, '93, of Drawing and Descriptive Geometry; and John O. Sumner, of Architectural History. The ninth was C. Howard Walker, '99, Special Lecturer on the Philosophy of Architecture and the History of Renaissance Art.

Redfield Proctor, '02, former Governor of the state of Vermont, from a photograph made at the time he took office on July 1, 1933, as the 40th President of the Alumni Association.

■ In July, 1933, three undergraduate dormitories of the original group opened in 1917 — Crafts, Nichols, and Holman, situated behind the President's House — were being converted to become the Institute's first Graduate House, which would "accommodate 90 students, or approximately one-fifth of the entire Graduate School. . . . A number of rooms," continued the announcement, "have fireplaces, and all will be completely furnished, including attractive rugs and draperies. They will have complete porter service, and an interconnecting telephone service will add to the facilities for communication." The appointment of Avery A. Ashdown, '24, instructor in the Department of Chemistry, "as Faculty master of the Graduate House was also announced."

Slide Rules and Paperbacks

■ Reports covering the year's activities of the M.I.T. Alumni Association provided the major fare for the 332d meeting of this body which gathered at the Faculty Club on the evening of May 26. After dinner, attended by 137 members and guests, Gilbert M. Roddy, '31, President of the Association, opened the meeting by calling for the Secretary's report.

Association Secretary Donald P. Severance, '38, reported changes in class affiliation for three recent graduates, and that 13 members of the Institute's staff visited 14 M.I.T. clubs across the country between May 1 and May 26. Also reported was the action of the Executive Committee in electing the following officers of the Association to serve for an additional year: H. E. Lobdell, '17, as Executive Vice-president; Donald P. Severance, '38, as Secretary-Treasurer; and Miss Madeline R. McCormick, as Assistant Treasurer.

A budget of almost $95,000 for 1958–1959 operations of the Association was reported as having been approved by the Executive Committee, which also voted to return to the Alumni Fund an unexpended portion of last year's budget. The Executive Committee approved recommendations of the Alumni Fund Board that $100,000 be appropriated to provide for Alumni Fund National Scholarships for members of the Class of 1962, to be made available in amounts not exceeding $25,000 per year for the period 1958–1962, and that $15,000 be appropriated to provide for the Alumni Fund Scholarships during 1958–1959 for members of the Class of 1960 who have received Alumni Fund Scholarships during the current academic year.

For the Committee on Honorary Members, Leicester F. Hamilton, '14, reported that Miss Madeline R. McCormick had been unanimously nominated for honorary membership in the Alumni Association. Miss McCormick has been employed on M.I.T. Alumni matters at the Institute for 39 years, and since 1950 has been assistant treasurer of the Alumni Association. Through her many years of continuous devoted service and loyalty to the Institute and its Alumni, she has become known to an extraordinary number of M.I.T. Alumni all over the world. Professor Hamilton's report was received with enthusiasm.

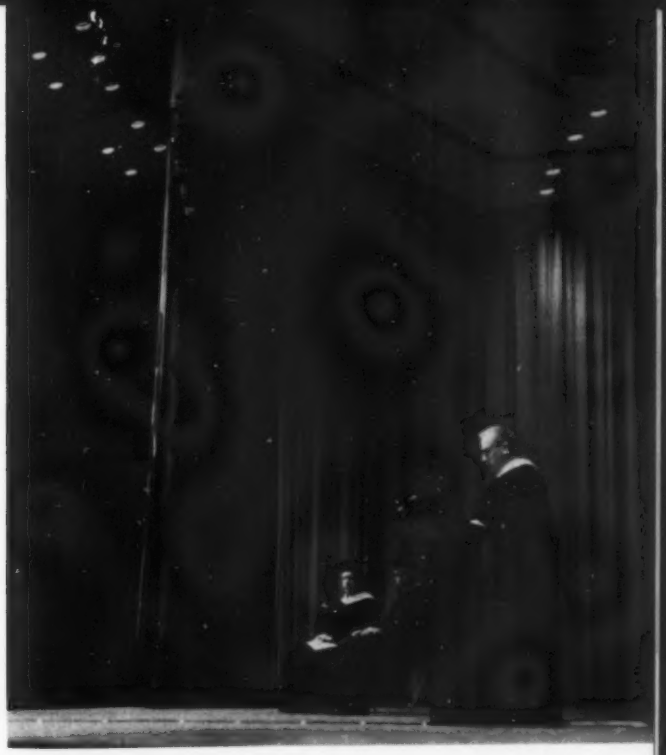
(*Concluded on page 534*)

Zest for Living

To one who has genuine curiosity and interest in the world and its people, the world ever has interest

BACCALAUREATE ADDRESS

by HAROLD L. HAZEN



Participants in the baccalaureate service were, in usual order: Chancellor J. A. Stratton, '23, R. E. Jordan, 3d, President of Class of 1958; and Dean H. L. Hazen, '24.

As I observe friends, acquaintances, and other people, one of the ways in which they differ among themselves is in their fundamental enthusiasm for life. For some, passive preoccupation with life's little labors and time-fillers hopefully evades boredom. For others, life is a privileged experience, full of interest, indeed fascinating in the power of its appeal. This difference in attitude toward life seems important to me, worth examination and thoughtful consideration. We may characterize this difference in attitude as the absence or the presence of a quality we may call "zest for living."

Zest for living, it seems to me, is important for very personal and selfish reasons. Habitual devotion to the routine and familiar trivialities of life gives only small satisfactions. If over the years we grow to see the world as a dull place, lacking interest, and failing to arouse our enthusiasm, we stagnate, then wither, even though we remain alive physically. Apathy toward life, or worse, lack of awareness of life and the world about us, if not actually criminal is at least a pitiable waste of great opportunities.

On the other hand, the phrase "zest for living" brings to mind the image of a buoyant spirit, a person enjoying life, one who finds it exciting, one for whom the days are always too short. For him life and living are adventure, an exhilarating experience, of which there is never enough. He finds life good.

But zest for living has more than selfish significance. Among the forces that move man to accomplishment, zest for living is important. What that inner emotional force is that makes men think, work, and act to constructive ends is elusive. It is buried deep within us, but somewhere near this vital force, and rather closely associated with it, I am convinced, is the spirit that finds life good, that finds satisfaction in productivity, and that generates buoyancy from active participation in the life and thought about it. It is an important force in human life.

Many influences affect zest for living. Strangely enough, physical infirmities do not necessarily destroy or prevent zest for living. Inspiring and challenging to us all are examples, of which Helen Keller is perhaps the most spectacular, of people with major handicaps who nevertheless have achieved great zest for living. Age and the aging process have some correlation with it, but with notable exceptions. Youth with its natural buoyancy tends to have this zest in generous measure, yet youth alone is not enough. We all know of the depths to which adolescent depression can descend, and how the normal vigor of the early years of maturity sometimes lack motivation. On the whole, however, the sheer physical energy and vitality of youth tend toward an optimistic and positive outlook on life that readily surmounts obstacles that appear formidable to older people.

It is in later years when the unbounded energy of youth develops obvious limits that the differences among individuals in their zest for living begin to show more clearly. Middle age tends to be a turning point in this regard. There are those whose habit patterns become established in a circumscribed routine and for whom change ceases to occur, in response to environment, or in ideas and outlook. A static state of the mind and spirit seems to set in. Others, however, on reaching this middle period of life somehow succeed in maintaining the zest for living with no impairment. A person of 80 who has maintained this zest is an inspiration to everyone.

For you of the graduating class these years of middle and later life seem a long way off, and you feel little concern for them now. Yet the pattern of

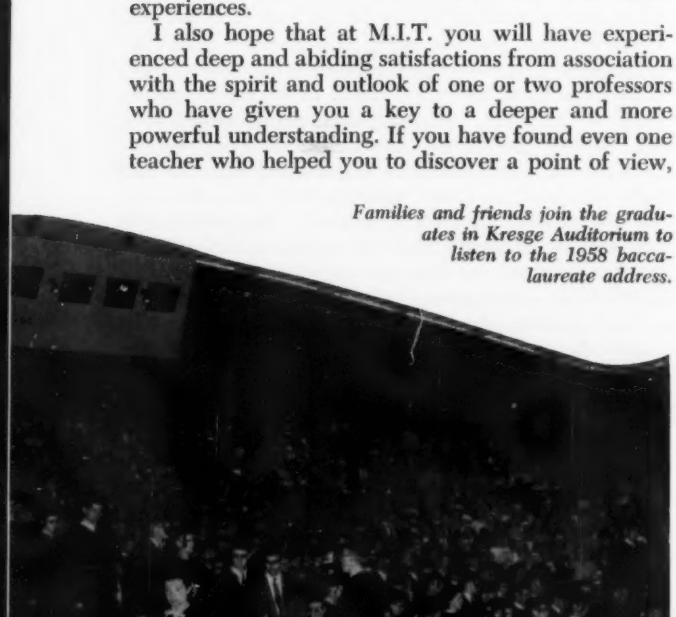
life you establish in the next few years will influence significantly your success in building and maintaining an enduring zest for living.

How can we go about cultivating this quality, and how keep it alive as we grow older? This is a question that is particularly pertinent for you at this time. As students you have been guided and to a considerable extent paced in your intellectual activities. True, there is a wide variation in the response that each of you makes to the challenges that you meet in college. You may feel that during your college years there has been precious little opportunity for development of the ebullient outgoing spirit.

But I hope that among the hours of hard work, you have experienced memorable moments of insight and inspiration. For example, in your study of mathematics you may have experienced the thrill of suddenly perceiving the power implicit in the elementary notions of the calculus. To see a vast new area of previously unattainable intellectual territory suddenly opened up with liberating new concepts can be an important emotional experience.

I hope that also in your reading and study, and your discussion of human ideas and institutions you may have experienced episodes of inspiration. Perhaps Fifth Century Athens showed you developments of the human mind that you found thrilling, or the Middle Ages emerging into the Renaissance as expressed by a great Gothic cathedral showed you heights of the human spirit to which you could react with warmth. Perhaps you have discovered Bach, Beethoven, or Bartók. In the scientific field, the elegance and beauty of Newton's great concept of gravitation, or Maxwell's marvelous generalization of the electromagnetic field may have given you new insights of mind and spirit, new sensitivity to the excitement that can lie in ideas and intellectual experiences.

I also hope that at M.I.T. you will have experienced deep and abiding satisfactions from association with the spirit and outlook of one or two professors who have given you a key to a deeper and more powerful understanding. If you have found even one teacher who helped you to discover a point of view, a method of thought, a courage to attack new and unfamiliar situations with confidence, and above all, one who inspired in you a sense of adventure and excitement in the life of the mind, you have received the most valuable benefit this institution can give.



Families and friends join the graduates in Kresge Auditorium to listen to the 1958 baccalaureate address.

You are about to graduate now. From this time on, unless you continue further in the academic world, you will make something of a change in course, in the navigator's sense. At the Institute, the pace, the task, and to some degree the pattern of life have been determined for you. As you go out to begin your professional career, the setting of pace, and especially of the pattern of life in mind and spirit, become much more your responsibility. You will, in much greater measure than heretofore, determine what is important to you. Consciously or unconsciously you will set values on the various alternative uses of your time and the uses of your physical and mental energy. What are you going to consider the more important, what the less important uses? To what kinds of experience will you look for the most enduring satisfactions?

We can illuminate these questions in terms of the negative. There is the tragedy of boredom. The waste of good resources of mind and spirit through boredom is bad enough, quite apart from the resultant unhappiness. Fortunately, I think this phenomenon of boredom is fairly rare among Tech men and women. Perhaps more insidious is the phenomenon of half living, of being comfortable in a passive sort of way, but of missing live, interesting ideas and activities, of living a bit too much like a healthy vegetable.

At the positive end of the scale I would put zest for living. Many of those who have graduated here before you have achieved and are continuing to achieve a remarkable degree of zest for living. Many others achieve it to a modest degree or perhaps only over somewhat restricted segments of their activity only.

What are some of the ways in which Tech graduates achieve zest for living, and in contrast, what are ways in which they may tend unfortunately to circumscribe or limit the areas in which they achieve this buoyant and sustaining spirit?

In their professional field our graduates, in common with most professional people, by and large achieve notable zest for living. In the first place, the M.I.T. man has at least good professional competence. He practices his profession, knowing that he is doing an intelligent and competent job. This job is normally one that contributes to satisfying some legitimate and often important human need. It is a worthwhile job; he produces a constructive result. He finds satisfaction in such a job, and this in turn normally produces enthusiasm and verve. This is a sort of minimum attainment for our graduates.

Among those with more outstanding abilities and ambitions are those who produce outstanding contributions – new discoveries, new products, new structures of beauty, new insights into the world about us. Such individuals often seem to have an unusual zest for life. Whether this be cause or effect, or an interaction between the two is less clear. But he who is notably creative and productive in his own field

often seems to have a zest for life that extends out and beyond his professional field. In a recent radio broadcast, Harlow Shapley, the famous astronomer and a member of the M.I.T. Corporation, when asked about his various areas of interest outside astronomy lightly characterized himself as scatterbrained. He illustrated by describing some of his studies on the traveling habits of ants. He started these out of idle curiosity at Mt. Wilson Observatory during the daylight hours, while he waited impatiently for darkness to permit him to get on with his astronomical observations. This was at the time when he was making observations for his now world-famous work on variable stars. I cite this as an illustration of the breadth of interest of many of our most creative people.

In our home and family life we Tech people appear to be at least as successful and probably more so than the average citizen of our country. Home and family are institutions based upon very fundamental human needs, instincts, and urges. We would expect that our group would go about building them on sound foundations in a reasonably intelligent sort of way.

It is when we begin looking into our relations with the community, with the world about us, with activities that concern people rather than things – with ideas, human understanding and values – that the scientific and technical fraternity must struggle more vigorously to achieve zest for living. We seem by nature to be less interested in, indeed less sympathetic toward, those areas of human activity that lack the responsiveness to the hard logic characteristic of the orderly and dependable physical phenomena of our chosen field.

The social or political question that has no single right answer, indeed too often no apparent answer at all, bothers us. We physical scientists are not accustomed to accepting this sort of situation without a sense of frustration and defeat. We expect our problems to have answers, and answers that experimental study, intelligent analysis, and good hard work will make clear to us. Some of the great problems in the social scene, such as segregation for example, seem too amorphous to resolve, too involved to cope with; they contain too many irrational elements not amenable to analysis and straightforward solution. Nevertheless we must, if we are to be honest and responsible, recognize these problems as real, legitimate, and demanding serious effort, even though no answer can be seen. After all, the absence of an apparent answer will seldom stop us in our professional work.

The political world of today contains so many trouble spots, so many great and fundamental conflicts in outlook and ideology, such threats, indeed to our very existence, that our instinctive reaction may tend to be indifference, if not hopelessness and frustration. The tools of our profession, clear logical analysis, experiment, rational design, too often seem to have little relevance to the great problems that face us today in the world of politics.

What then will be our response to these great social and political questions? It depends very largely on us, on our attitude, on how we elect to view these problems. We can elect to view the world today with

Officers of the Class of 1958, in reading order, are: H. G. Johnson, West Hartford, Conn., Secretary-Treasurer; H. R. Warner, Kent, Ohio, Vice-president; R. E. Jordan, 3d, South Boston, Va., President; and W. H. Austin, Jr., Rome, Ga., Senior Marshal.

pessimism, a sense of futility, fatalism, or mere apathy. We can react with uneasiness, with a primitive fear of the unknown, with a sense of defeatism before forces beyond our knowledge and control. We can regard ourselves as unwilling victims watching the mortal contest of the political giants whose struggles threaten to carry all of us down together into oblivion. This view presents a stark and dismal picture to which we can reconcile ourselves only by ignoring it or by putting it out of mind as much as possible. This is the ostrich solution.

But we can elect a quite different outlook. We can see in these events one of the great epic dramas of history enacted before our very eyes, day by day, unfolding with unprecedented speed, intensity, and scale, and reported almost instantly in great detail as it happens. There is, however, an inescapable price of admission for those who would witness today's events as great epic drama. This drama is complex, unbelievably complex; it has many actors; its plot is extremely involved and extends backward from the present ultimately beyond the limits of the recorded history. To see today's events therefore as a continuing drama requires knowledge and understanding, both of the contemporary scene and of the background from which it has evolved. The greater our knowledge and understanding of the earlier acts of this drama, the more we know about the cast of actors, the greater will be our appreciation of it. With understanding and perception of today's events, we can feel glad to be alive in such exciting times. Here

then it seems to me that we have the power of choice between an unhappy and depressed response to world events on the one hand, and on the other hand, a response that adds to our zest for living. Our choice is determined largely by whether or not we attain some understanding.

I should like to explore further this thought of understanding as a basis for zest for living. In the professional field, as we have noted before, understanding is taken for granted as a condition for achievement, and of the spiritual rewards of achievement. But so I believe that understanding is also an important great, indeed essential, element in achieving zest for living in areas outside the professional field.

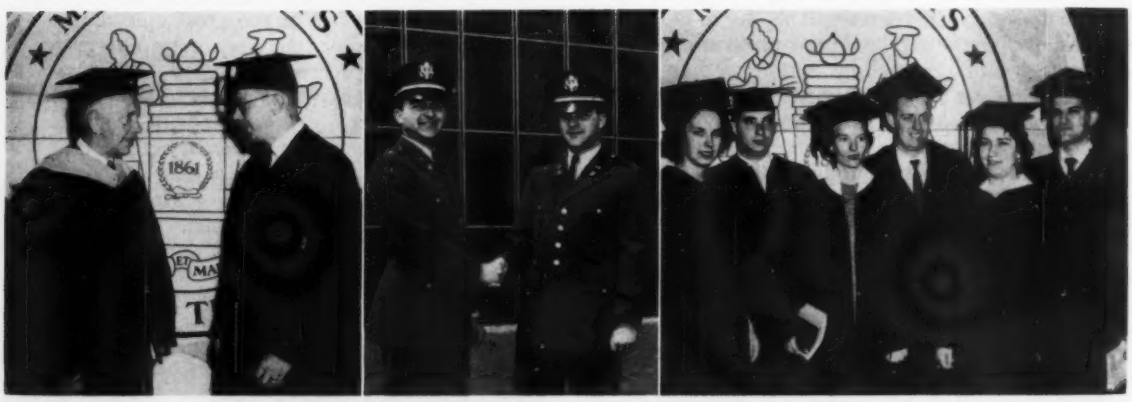
One of the men who opened a number of doors to me in youth, an unusually intelligent minister of the gospel in a small Midwestern town, suggested as a worthy goal in life the mastery of one field to the point of professional competence and authority, and the development throughout the range of non-professional fields of such acquaintance as to be able to listen and to inquire with some perception and understanding. I have long found satisfaction in this dual goal. Both of its phases have contributed to my zest for living, each in its appropriate way. May I suggest a few random examples of contributions that wide-ranging curiosity and inquiry can make.

First, in the realm of the physical world where most of us find our professional home in some particular corner, do we pause to see and marvel at the beauty of the atom, at the absolute order and dependability of the physical world, at the awesome grandeur of the universe? In science we are living at a thrilling time. Our image of the physical universe has been developed both in great scope and fine detail. Our understanding is growing at a tremendous rate. Right now, at the small end of the size scale, the particles of which the atomic nucleus is composed are the subject of feverish study and speculation, and of experiment by some of our most brilliant minds. These particles are extremely small and difficult to study. The ingenuity and mental power brought to bear in discovering their nature merit, it seems to me, the same order of respect and reverence that we accord to the work of the greatest artist or philosopher.

At the other end of the size scale is the vastness of the presently observable universe. Is it not remarkable that the astrophysicist studying its farthest reaches uses the same nuclear and atomic physics as do those scientists working with the smallest particles! One of the marvels is the range of the sizes in the universe. Thus the diameter of the now-known universe is about as much larger than a 100-mile distance as a 100-mile distance is larger than the diameter of the proton. The sweep of these dimensions is beyond our comprehension. Yet throughout, from the minute to the immense, we see law and order; we see elegance and majesty of design that beget wonder and profound humility, yet also a pride at being a part of it all. To have some elementary comprehension of our physical world as our scientists now see it is to find an intellectual excitement of the first order.

Let us glance for a moment now at another field, the great field of life as seen by the biologist. Here we also find that a remarkable richness of understanding has been achieved, which however but serves to identify some of the tantalizing puzzles yet to be solved. In the world of life also we have a tremendouse size scale, from the most minute virus molecule capable of self-reproduction and thus identifiable as life, through a vast world of unicellular organisms up to the most complex organism of all, man himself. The biologist is feverishly studying the cell because he feels tantalizingly close to understanding its basic structure and operation. In genetics, the science of heredity, he can almost see the relation between chemical molecular structure and the magic pattern by which a species is reproduced in kind through countless generations, and in the case of some of the minute unicellular organisms, reproduced without discernible change almost since life began on this planet. The great phenomenon of photosynthesis, by which all life obtains its vital energy from the sun, is awe-inspiring. The layman who will take the time to examine with a microscope, and un-

(*Continued on page 506*)



(Left) *Chancellor J. A. Stratton, '23, chats with William D. Couper who received two S.B. degrees and one S.M. degree at commencement exercises.* (Center) *Twins Richard M. Gottlieb* (left) *and Michael M. Gottlieb received their R.O.T.C. commissions and bachelor's degrees this June.* (Right) *This year's graduates included three married couples, each spouse of whom received a degree They are: Mr. and Mrs. Alvin W. Drake, Mr. and Mrs. Alexander MacLachlan, and Mr. and Mrs. Nicholas A. Spinelli.*

Obligations of the Scientist

Society needs the venturesome instinct, the willingness to dissent, the refusal to conform while serving his fellow men, which characterizes those trained in scientific disciplines

COMMENCEMENT ADDRESS **by JOHN J. McCLOY**

FROM a number of points of view this occasion places a heavy burden on the speaker – certainly on this speaker.

In the first place, a commencement audience always poses a disconcerting challenge. There is the inescapable and unnerving expectation that one who speaks to such an audience will sound some stirring note fittingly to mark the end of a course well run, and just as fittingly to set the runners resolutely off on another.

Then again, there is the setting. The mere name of this institution has always awed me. My education was also attempted in this general area of the country, but always, in my mind, M.I.T. stood for something ominously mathematical and difficult. As one whose engineering skill was completely exhausted by the perversities of a pulley problem, I have never failed to wonder how anyone ever got through here. I mean no disrespect when I say to you today, "However in the world did so many of you, who appear from here to be of no more than normal intelligence, manage to slide by?"

And then there is the time. We are in a great scientific revolution, perhaps the most startling and perhaps the most crucial of all times. Never has man lived before, as Eiseley puts it, "in so great an age of exterior accomplishments, so tremendous a projection of himself into his machines . . ." when the world is athirst for engineers and technologists – when man has just been handed by the scientists a product capable of destroying his world – and when the world still gives strong evidence of being quite capable of indulging in the delusions and stupidities which could bring that destruction down upon us.

Finally, there is the audience itself, for which I can think of no better designation than "elite."

I think you must agree then that it is difficult to do justice to such an occasion, particularly when the speaker himself ponders the future, and is so perplexed by the crosscurrents of our times. Undaunted, however, I will talk briefly about some of the major challenges which crowd this Commencement Day, and endeavor to find some responses that would help to meet them.

I suppose we could agree that our primary, if not our total, challenge is the existence of weapons capable of our complete or near-complete destruction. The world is today groping with the practical, the moral, and the philosophical implications of this reality.

Next, there is the rapid emergence of Russia as an impelling, revolutionary, and all-pervading force in our greatly foreshortened world. I have never ceased to marvel at the prescience of de Tocqueville when, over 100 years ago, he saw so clearly the future of the United States and Russia. The passage has been frequently quoted and by this time is so familiar that I shall only repeat the last sentence of it: "Their points of departure are different, they follow different paths. Nonetheless, each of them (Russia and the United States) seems intended through some secret design of Providence to hold in its hands the destinies of half the world."

The third great challenge is the restlessness surging through the underdeveloped races and peoples of the world, which induces an entirely new relationship between them and the so-called developed countries, between the white and the colored, between the advanced and the primitive. Thus, we face a scientific challenge, a political challenge, and a social challenge – each of imposing proportions. But in this shrunken world and in the compression of our time, these challenges are fused and confront us daily inseparably.

Other trends or phenomena might well be singled out in a list of the great issues that face us, but these that I have mentioned, like Mercutio's wound, will serve.

So massive and so exacting are these challenges, and so often do we seem to fall short of meeting them, that one is led to question whether our political and governmental systems are flexible and efficient enough to cope with these new world forces. For those engaged in our public affairs, the calls upon their energy, patience, and nerves – exasperating as these are in the obstacle course of the democratic process at home – are geometrically multiplied by the necessity of attaining a concert of action with our allies, who, in greater or lesser extent, endure with us the checks and balances, the traps and hurdles, and the vagaries of democratic processes. Yet to lose those processes is to abandon the field.

We cannot, of course, continue to be smug or uninventive about our habits of government or our bureaucracy. The French scene is today a sufficient example, if we should seek one, of the serious dangers implicit in governmental ineptitude. There is much of administrative and bureaucratic underbrush that will have to be cut away if we are to find a clear path of security and progress. But I suggest

that our fundamental democratic forms, awkward as they may be at times, are adequate to the task and indispensable to the goals we seek.

The vital need does not lie in changes of structure or administrative machinery. The need is for men and thought – the best that can be found and produced in this richly endowed nation.

We must be braced for the unequaled tests of spirit, talent, and wisdom that lie ahead. The business of government has become the most complex, the most difficult, the most abstruse, and at the same time, the most pervasive influence in our lives. Under these circumstances, is not the obligation bearing upon you, a true elite, quite clear?

I read a speech which Professor Carlo Schmid of the Johann Wolfgang Goethe University of Frankfurt and a Vice-president of the Bundestag gave in Hamburg recently. He was attempting to state the lessons to be drawn from the failure of the elite of Germany to respond to the challenge of Hitler. As a scientist, he was attempting to define the obligation bearing upon the intellectual to participate and to proffer solutions in governmental affairs. There was an obvious default in Germany on the part of the elite to involve themselves during the Nazi era. This was a period of unaccepted challenge, but serious as that challenge was, are we not now faced in these United States with one wholly different in nature yet quite as crucial?

"The state," said Schmid, "must be placed under the vigilance of the intellect, and who should be responsible for this other than just those people whose task it is to influence things with their minds?" He went on to say that the intellectual elite is useless when it places itself outside or above the community, and that the intellectual mistakes greatly if he considers that his superior intellect gives him the right to feel superior; rather it should give him humility to serve, "to bow down towards the earth – this earth on which the ruins lie and the weeds grow."

Acting President J. A. Stratton, '23, John J. McCloy, commencement speaker, and President James R. Killian, Jr., '26, photographed at robing ceremonies prior to commencement exercises.

Here then lies your duty. But what of your qualifications to discharge it? Are you equipped to carry the unmatched responsibilities that might and should be placed in your hands? It is in some recognition of this obligation that your Institute, since the time of Aydelotte, has so sharply increased the weight of its curriculum on the humanities side.

But it is well to remind you that this growing concern with the humanities, with ethics, with society in the world of the scientist is not the mere addition of new seasoning to an old recipe. It is rather a recognition and renewal of what is inherent and fundamental in the scientific spirit itself. For the search of the true scientist is for meaning, for cohesion, for unity, as he finds his way through a labyrinth of seeming disorder and disconnected observations. The spirit of science is to set men free – free of superstitions, of chains, of slogans, and of dogma.

If, then, you are a true man of science, if you are a graduate of M.I.T., then you should be admirably equipped to take up the challenge of the times – to become involved on this earth.

Robert Lovett, with whom I have had many missions in common during the war and afterwards, called my attention the other day to a talk given by Merle Tuve, of the Carnegie Institution, which dealt most eloquently with the liberalizing influence of science. It impressed both him and me so much as an interpretation of the spirit of science that I should like to repeat it to this audience:

> The beauty and simplicity of the laws of nature which govern the world in which we find ourselves, the fantastic range today of man's ideas and studies and measurements, from the countless galaxies in the distant reaches of outer space far beyond the faintest stars of our own Milky Way, down to the structures inside the atomic nucleus, this is vision enough to humble the most arrogant. The chemical forces that build molecules and crystals, the beautiful simplicities of genetics, the astonishing patterns of life, from protein synthesis to instinct and behavior – these are the new materials for the artist to comprehend and use. The poetically beautiful patterns of modern scientific knowledge bear fresh witness in a whole new range of thoughts and qualities and dimensions to the psalmist's ancient cry –
>
> "The heavens declare the glory of God and the firmament showeth His handiwork."

He goes on to say this is the spirit of science. It is not airplanes, Salk vaccine, or anticoagulants for heart patients. These are technological developments flowing from the content of science.

But do not allow the eloquence of this passage to blind you to the fact that the spirit thus engendered is only the base upon which you have to build. Merely because you are a scientist you do not thus become qualified to propound solutions to the world's political and social problems. You have to do more than sign an intermittent manifesto from the isolation of your laboratory demanding of the government some immediate course of action. It requires

As Dean C. Richard Soderberg, '20, calls out their names, graduates in the School of Engineering receive their M.I.T. degrees.

added knowledge, added reading, added thinking, and added experience, all inspired by the scientific spirit. It requires dealing, incidentally, with subjects wherein the variables are apt to be far more numerous and baffling than in any scientific problems you have thus far encountered.

I can recall that just after the first Sputnik went up, when so much emphasis was being placed on the need for experts, President Eisenhower, in the midst of all his problems, said that he would gladly trade a dozen of the finest engineers and scientists, precious and rare as they were, for just one thoroughly reliable moral philosopher. What is the right thing to do may be more important to determine than the means by which it is to be done. I wonder if this cry in the wilderness of our perplexities is not a reflection of the need for a broad appreciation of the humanities, lest the pursuit of the means obscure the verities. The truly great scientist has always been more than a technician. The mark of his greatness is his breadth of vision and his ability to interrelate his work and the society around him. I need only mention such names as Aristotle, da Vinci, Newton, and Einstein. In fact, it is difficult to find any real genius who was limited to a specialized compartment.

A short time ago I spoke at the Washington and Lee University Law School on what I called the role of "The Extra-Curricular Lawyer." Primarily I had in mind the lawyer's role in government and in business, not in connection with his regular profession, but as he from time to time stepped out of that profession to play a part in a wholly different field. In this connection I did a little research to determine how many lawyers there were who had made contributions in government and in business, and I suppose it would not be surprising to you if I said there were far more lawyers than scientists who became congressmen, senators, governors, cabinet members, and diplomats, as well as heads of large corporations. Although there are certain attributes the lawyer has, good or bad, which seem to gravitate him toward public service, it is comparatively rare to find scientists in government as such, as distinguished from their attachment to government as technicians or scientific advisers. Yet the scientist might well contribute as much or more than the lawyer has to our public life. In trying to analyze the lawyer's contribution, I referred to a comment of Mr. Justice Frankfurter's which in effect suggested that the lawyer's chief contribution or qualification lies in what he called his expertness in the "art of relevancy." I would suggest the precious quality which the scientist can offer to his community and to his society is the habit of integrity which derives from the scientific approach. Certainly, at least as much as the lawyer, the scientist is concerned with the search for truth. He wants no preconception, no prohibitions, no prejudices to blur his vision or to divert his search. Society needs his doubts and his venturesome instinct, his willingness to dissent, and his refusal to conform. It needs them not only in the confines of his laboratory or university or his own company plant or research center, but also in the broad area of political, social, and economic action. It used to be said that politics and science do not mix, but with the implements that science has given mankind, from Galileo's optics to the Manhattan project, they have had to mix. Each, as it came along, has plunged science deeper into politics and politics deeper into science. Think for a moment of what tremendous human and social implications are necessarily involved in the exciting new fields of biochemistry. Somehow when it is suggested that these interests do not mix, I am reminded of Thomas Carlyle's remark when it was reported to him that the very vigorous and animated critic, Margaret Fuller, had finally declared that she accepted the Universe. "Gad, she'd better," said Carlyle. And so, the imperative that I would place on the man of science, or technologist if you will, is an appreciation of the global character of his work. By this, I mean a sense of collaboration and relationship with other people, the people not only in his own community and his own nation, but people of other nations, other races — an appreciation of their needs, aspirations, and sensitivities.

Now that we have you involved in the outer space of world affairs, perhaps one of the first things we ought to do is to take stock of our position in the world. We appear to be in a period when much of the world dislikes us, or at least acts and speaks as if it did. To find the proper response or counter to this attitude may well be a field for the calm, objective, and penetrating analysis of the scientist to explore.

Depressing Array of Headlines

Just a short time ago I had an experience which I am sure I shared in common with most of you. I read the first page of the morning newspaper and it was packed with the most depressing array of headlines – Vice-president Nixon and Mrs. Nixon stoned and spat upon in Caracas; Beirut crowds burning American libraries; Tokyo riots stimulated by anti-American attitudes; Algiers in revolt with crowds destroying American property – unrelievedly unpleasant reading. Crowded off the front page by all this news was an article condemning American betrayal of liberal principles because we were not supporting the anti-Communists of Sumatra, while another from Jakarta charged us with offending liberalism because we were. A day or two later, the 3,000-pound Sputnik III was in orbit with Khrushchev calling ours an orange. On the same page was the Khrushchev-Nasser communiqué, ominous and threatening, in respect of an area of deep concern to the West. And, as if we did not have enough in the way of disapproval or criticism of our actions, there was Ambassador Merchant's testimony in regard to good neighbor Canada's widespread irritation at us and our tendency to take her somewhat for granted. "Et tu, Canade?" I felt like saying, but maybe I should have expected even this.

Indeed, we are blamed for so many things from so many quarters that it seems that a kind of rash has broken out all over the world. The criticisms, while significant of something, are certainly not marked by their consistency. I read, the other day, an article written about two years ago accusing us of outrageous behavior because by our inordinate demands we were keeping commodity prices high, while today we are being attacked from precisely the same quarter for permitting them to stay low.

I gained a little comfort from the fact that shortly after I had taken a trip around the world just after the close of the war, I wrote how terrified I was by the esteem in which we were then held and the extent of the hopes which then centered about us. I can remember feeling then that no nation could possibly be that representative of good in the world, and I must say that I feel now that the United States could not possibly be so influential for evil in the world as the combination of headlines, bewailing commentators, the Kremlin, and not a few of our friends presently make us out to be.

Yet, however irrational these tendencies may be, it is essential for our leaders to judge these imponderables, to appraise them fairly and find the answers, if not in terms of universal popularity, at least in terms of dependable and well-sustained national and international objectives. Moreover, it would be a matter of real significance to us and to the world if America did not continue to throw a beam of hope across the seas. I believe it was Kelvin who said there is no science without measurement, but these things defy measurement, even as many aspects of higher mathematics today transcend measurement. They require the constant application of the highest and broadest types of knowledgeability and intellect. It would be futile and naïve to search for the Eldorado of universal popularity, and foolhardy to sulk over the hurts that leadership invites. But we do need to define, and better expound than we have recently done, our long-range national objectives – objectives worthy of our genius and strength. Again the emphasis is on training and perception of the highest order, and our educational system must produce the elite of mind and character with the capacity and the sense of obligation to advance the solutions. We find Russia undergoing a veritable passion of educational endeavor based on a broad and ruthless selective process which is much more demanding than anything our educational system represents. So much more rigorous is their process that we need not worry about having plenty of room within which to tighten up our own methods before we remotely approach any threat to our liberties or egalitarian principles.

How to find the proper balance between our present system which, as John Gardner put it here last year, permits quite a few of our colleges to flourish at a democratic level somewhat below that of the good high school, and the Russian system is another challenge of our times.

Knights of Progress

It is problems such as these for which, as never before, we must look to the scientists and the engineers to give us answers, not by mere advice or prompting from the side lines, but by positive participation. The scientists are the new knights of progress. Those taking their degrees here today will be held in higher regard and be given greater opportunities than ever before, but it will mean that they now are obligated by a higher responsibility than ever before.

For example, in the vital field of technical assistance to less developed peoples, we have only begun to scratch the surface. Douglas Dillon, our Under-Secretary of State for Economic Affairs, has told us how readily and effectively the Soviet Union is able to pluck technicians out of the home environment to send them overseas to fill a gap in technical aid. We cannot match them in this, since our technicians can say no. But young men, such as yourselves, can add much to the reservoir of talent and of service in this most critical field of our international relations. If 10 per cent, or even 5 per cent, of you would determine now that you will make your contribution to this challenging program, our confidence in our future relations with the peoples of Asia, Africa, and Latin America might be immeasurably enhanced. It might mean that the steady job, social security, the flight to suburbia, and even early marriage, will

(*Continued on page 514*)

Maintaining the Strength of U.S. Technology

Engineering has a pivotal responsibility in our total technological effort. Today's exacting demands call for more engineers nurtured in the atmosphere of research

ALUMNI DAY ADDRESS **by JAMES R. KILLIAN, JR.**

AFTER a trip through the outer space of public life, I find this brief re-entry into the academic atmosphere comfortably smooth and free of ablation – and marked by a lump-in-the-throat reaction of delight in coming home. After so long and so uninterruptedly viewing M.I.T. intimately from the inside, I have had a revealing experience in seeing the Institute from the outside. In the perspective of distance, it does appear different; the intimate details which seemed, close-up, so important and impressive fade out, but its comely proportions become clearer and more complete. Like a great mountain seen at a distance, its true shape and size and its position in the range are perceived more clearly.

The experience of being away also enhances one's appreciation of M.I.T.'s human resources – and resourcefulness. During my absence, the members of the Institute's Administration have picked up extra burdens and carried them comfortably and well and have demonstrated clearly that the Institute's Administration has strength and depth. It also has had spirited leadership of which we can be confident and proud. As Chancellor and Acting President, Dr. [Julius A.] Stratton ['23] has turned in a tremendous performance, and we can hail him as a leader we cherish and admire. In addition, M.I.T. has again been privileged in the wise and stimulating presence of Vannevar Bush ['16], this time as Chairman of the Corporation. He has brought new wisdom and luster to our academic community. These and many others have carried extra burdens, and at the same time carried M.I.T. steadily ahead.

In view of my present assignment, you might appropriately expect of me today some observations about the current state of American science and technology and about the requirements we face for maintaining strength and progress in these fields.

Sir Winston Churchill once remarked on the importance of separating the "awkward incidents of the hour from the long swing of events." This we need to do as we appraise our national position today. We have experienced awkward events. For example, we cannot yet throw into orbit as large satellites as the Soviets, because they started to develop the technology of rocketry earlier than we. This does not mean, if we use energetically the great resources we have, that we will not match these achievements in the future or that we have fallen behind in other fields. It does mean that we face implacable, able competition in all of science and technology that will require us to strive mightily – but intelligently – if we are not to be surpassed in the protracted conflict with Communism. There can be no *foreseeable* let-down in our efforts to maintain and augment the military strength that will deter war, or in our efforts to be creative in finding *non*military ways to minimize the hazard of war. While recognizing our strength and while avoiding any spirit of defeatism, we must not deceive ourselves about the increasingly exacting demands upon our will and strength yet to be imposed by the military, economic, and ideological competition of the Soviet Bloc – a competition which will require of us, not growing comfort and leisure, but self-denial and hard work, and a recognition that intellectual achievement is as important for survival as a high standard of living and material prosperity.

"Every good and excellent thing," Thornton Wilder once said, "stands moment by moment on the razor

In its exhibit in the lobby of Building 10, the Physical Science Study Committee demonstrates how it contributes to maintaining the nation's technological strength by preparing new programs of study in high school physics.

Lectures on inertial guidance in lecture hall of the Karl Taylor Compton Laboratories outline some of the defense research work going on at the Institute.

edge of danger and must be fought for." The Free World stands moment by moment on this razor edge and must be fought for. But as we in the United States accept these stern and unremitting requirements, it is important that we not let the awkward events of the moment lead us into expedient, frenetic or ill-planned efforts, especially in research, that will not contribute to the steady growth of our strength in the long swing of events.

Let me briefly list some of the requirements and needs, both private and public, we must meet in order to make sure that our science and technology match the needs of the nation, not only in keeping it strong militarily and economically but in contributing to its intellectual and spiritual vigor.

First, as recommended by the President, we must adapt the organization and management of our military research and development to keep pace with the rapid changes in military technology. Over the past five years, I have had an exceptional opportunity to study our military technology, and the cumulative effect of this experience has been to make me an ardent advocate of the reorganizational proposals which President Eisenhower has made for the Department of Defense. It is of transcendent importance, as the President has emphasized, that our principal military objectives be clearly defined and that each of them have strong and clearly focused scientific and technical support.

Second on my list of requirements for a sound national science policy is the achievement of a greater emphasis on the qualitative aspects of our national research effort. Because research is so fatefully important to our safety and welfare and to the stability and advancement of our economy, and because our investment in it has become so great, we must be more critical in appraising its quality. Today industry, government, and nonprofit agencies expend ten billion dollars a year for research and development. Are we getting our money's worth? More importantly, is this great research effort, which may not yet be large enough, as creative and productive as we can make it? We can no longer accept all research on faith, or believe that research, just because it is called research, is bound to be good. We must more generally recognize that first-rate research depends upon first-rate people – people working with a sense of mission and in a favorable environment, and that numbers can never substitute for quality.

The quality of our national research effort also depends upon the proper allocation of effort and funds among the several categories of research and development. We now give too much emphasis to development and too little to basic research.

Despite some serious gaps in our program, more first-rate work is now done in the sciences in the United States than in any other country. The challenge before us is to continue this leadership in the future. Our principal deficiency is at the great peaks of achievement over and above the first-rate, where the intellectual breakthroughs occur, where the seminal concepts and discoveries originate that appear only a few times in each century and that change the course of science. By heightening and broadening our efforts in basic research, we provide the best possible opportunity to bring about these achievements of genius and to nurture the great men who will advance all of our efforts, both pure and applied.

As I look at the total spectrum of our research and development effort, I see deficiencies also in the area between basic research on the one hand and development on the other – that kind of research that is sometimes called supporting research, or engineering research, or subsystems research. After observing many research and development programs, I am sure that we would avoid costly mistakes in hardware development if we saw to it that the supporting research was done more thoroughly. As the head of one of our great companies recently observed, "The cost of development is far greater than the cost of research, and if a big development gets off on the wrong foot, the price is terribly high."

In saying that we need more and better supporting or engineering research, I am also saying that we need to strengthen our engineering. Engineering has a pivotal responsibility in our total technological effort; and as this effort becomes more sophisticated, we need to draw more heavily on science, and we must have engineering education and practice equal to this new and more demanding complexity. We need more engineering research in our engineering schools and more strong graduate schools of engineering, not only because we need more of this research but because we need more engineers deeply nurtured in the atmosphere of research.

Since World War II there has been a great increase in the volume of research carried on in nonprofit institutions. There has not been a comparable increase in the capital equipment employed for this research, nor has the provision of equipment kept pace with the changing need for new devices for scientific measurement. So little attention and so few funds have been directed toward meeting this problem in the United States during the last 10 years that one

now finds that many university laboratories in Europe are better equipped than those in this country.

As our research activity has grown in universities, hospitals, and other nonprofit institutions, we have failed to meet this growth with a comparable increase in buildings. If American science is to realize its full potential, we must face up to this problem of capital needs. Science, no less than industry, cannot flourish when limited by obsolete plant and equipment.

I would stress the importance of maintaining and increasing research and development in a time of recession such as we now experience. Advancing technological knowledge provides a company with the agility to react rapidly to changing economic conditions. It helps create the conditions for renewed economic growth, for developing strength for the future. It helps in planning future goals, by the systematic, planned discovery of new products and methods of making them. This is true no less for the nation as a whole than it is for an individual firm. It would be a great pity if we foreordained a future hiatus in our growing technological and economic strength by permitting a reduction in our total national research effort now. In my judgment we need instead to increase basic research now because it is through basic research as it is conducted in the universities that we nurture the professional scientists and engineers of the future. It is heartening to note reports in the business press that U.S. business is taking the offensive by planning increases in research outlays, with the objective of creating "the new and better products on which their markets can expand again." We must also find ways to increase the outlays for basic research in the universities.

We also need to clarify the relation between science and economic progress. There is a widespread recognition that the economic pay-off of research is great, that it has created new products and expanded industry, that it has increased productivity and wages and introduced a new stabilizing influence in our economy.

While the economic effects of science are clear and accepted, there still remains much to be understood about the role of research in our economy. Especially do we need more refined quantitative measures of the economic forces generated by research, of the relation between research and profits, the return on research investment, the relation between research and productivity, and the contribution of research to gross national product.

I would emphasize that there are certain areas of both pure and applied scientific research where there is inadequate effort and which would benefit from national planning. A good current example is geophysics. The scientific community has made clear the opportunities and needs which face us in the field of space science, oceanography, and meteorology. There is a growing realization that we need to achieve a better understanding of the earth and its surrounding atmosphere and of the scientific interrelations between the earth, the sun, and other heavenly bodies. By achieving greater scientific understanding in geophysics, we can further the development of new technology which may permit us to counteract the depletion of the water table, to obtain greater protein from the earth, the ground, and the sea, and to find new mineral resources.

If we are to grasp these important opportunities, we must move on a wide front to achieve a co-ordination among existing institutions in the field and even through the creation of new research organizations. We must seek ways to bring together the oceanographer, the meteorologist, the physicist, the biologist, and the mathematician to form a joint attack on some of the very basic problems of geophysics. In the universities there must be revision of graduate curricula, new fellowships for graduate study, and new career opportunities provided which will attract first-rate scientists.

Another example of where we need a more concerted effort in the applied area of research is in the field of materials, particularly high-temperature materials. In order to make headway in materials research, we need one or more centers where a co-ordinated approach can be made.

So far in this discussion I have only indirectly stressed the strategic role of education in the maintenance of our technological leadership. I will not today, as I so often have, add to the great roar of educational discussion that has been in progress across the land. I will say that I hope that we will soon translate some of the talk into action, and that we will again, as the Soviets have, demonstrate a great passion for learning and a great national zeal for intellectual achievement.

Two other observations are in order.

In a still unpublished study of human resources in which I have had the opportunity to participate, the point is made that a society only produces great men in those fields in which it understands greatness. We

(*Continued on page 510*)

During his brief "re-entry into the academic atmosphere" of M.I.T., at the end of the school year, Dr. Killian enthusiastically takes on the role of "The Most Happy Fella."

Report of the Institute

A review of progress at M.I.T. in the past year emphasizes need for understanding the complicated interrelations between technology and our society

ALUMNI DAY ADDRESS **by J. A. STRATTON**

THE year that has slipped by so quickly since we last met together in this Great Court has been a momentous one for the people of our country. Happily the nation has managed to escape major disasters, both economic and military. But there have been events to cause every thoughtful American to take stock of both our aims and our human resources. Our national pride has been somewhat bruised, but I think it very likely that these events will have been salutary if we act upon them with wisdom and vigor.

I must report to you that the developments of this eventful year have had a profound effect upon M.I.T. It was inescapable that this should be. This great institution of ours moves in mid-current of the surging stream of modern life. The problems with which we at M.I.T. are concerned are in large measure the problems of our age. If there is any one lesson that has been impressed upon the American public these past 12 months, it has been an awakening to the interplay of science, education, and national welfare.

In November, President Killian was called to Washington to serve the President of the United States as Special Assistant for Science and Technology. The choice was so obvious and the need so great that we felt bound to urge him to accept. Yet may I tell him here today how very much his colleagues and I have missed his presence. In going to Washington, Jim Killian followed in the steps of other great men of M.I.T. who have occupied positions of high trust and responsibility at times of national need or peril – of Karl Compton and Vannevar Bush ['16], of Richard Maclaurin in 1917, and of Francis Amasa Walker before any of them. On this occasion, too, I think it appropriate to pay tribute to the members of our Faculty who in countless ways have been rendering service to the national interest. The full record of these contributions will never be compiled. But it is, I can assure you, a superb record of achievement and public spirit, a record that should fill us, as Alumni, with an even greater sense of pride and confidence in the basic strength and soundness of this institution.

Tents set up in Du Pont Court and the Great Court were provided in greater measure this year, to accommodate the large number of persons taking part in the luncheons on June 13 and June 16.

Against this background of national tension and challenge, M.I.T. has had one of its most productive years. In the few short minutes available in this luncheon program, it would be impossible to report to you adequately the scope and multiplicity of ideas and plans which are in ferment upon this wide campus. Of all these activities, however, to my mind the most significant aspect of the year has been the concentration upon the educational process itself – upon the aims and methods and the substance of both undergraduate and graduate teaching.

Every part of the Institute has been affected by this critical self-examination, but it has been focused most intently on the education of the engineer. Those of you who attended the Alumni Day Symposium gained some insight of the issues that are involved in this continuing discussion of engineering education. Because I consider these matters of such consummate importance, let me summarize them briefly.

At the root of it all, of course, is our conviction that human resources constitute our only true wealth – that the future of this world will be determined by the wisdom and competence of the oncoming generation. We have a dual task in educating them for their responsibilities.

First, we must provide them with the foundations of professional training which will allow them to deal with the complexities of modern technology and, even more importantly, to keep pace with its rapidly advancing frontiers.

Secondly, we must strive to impart to them an understanding of the contemporary world, of the interrelations of science and technology with society, so that with breadth of vision they may fulfill their obligations as citizens. Whether for good or ill, we

(*Continued on page 518*)

Soviet Education—A Lesson for America

A more profound educational approach is required in which scientific analysis becomes part of the thought processes of our people. Intellectual power is as vital as horsepower

SYMPOSIUM ADDRESS **by MORRIS COHEN**

On the fourth of October, 1957, our ancient Mother Earth bestirred herself and gave birth to a baby moon. The beaming father was not Uncle Sam but the Soviet Union. I had occasion to observe the impact of that event on the people of Moscow. There was no undue surprise or exultation, only a quiet pride in the achievement of their government and scientists. The public had been told that a satellite would be launched and there was little doubt about its coming to pass. To the people, this was but another "first" for the Soviet Union – of many in the past and many yet to come. Had not the Russians already built the first commercial jet aircraft, the largest particle accelerator, the first lithium H-bomb, and the only atomic-powered ice breaker?

Although October 4 marked the dawn of a new era in space travel, perhaps no less significant for mankind than the harnessing of nuclear energy, that day also ushered in a new respect all over the world for the remarkable progress of the Soviet Union in science and engineering. The evidence in this direction that had been accumulating over the years could usually be explained away or complacently ignored, but the meaning of Sputnik I came upon us like a dash of cold water. The shock, whether intellectual or emotional, was staggering. However, our awakening to the technological competence of the U.S.S.R., disconcerting as it was, may well prove a priceless blessing to America if we can read the lesson correctly.

General Role of Education in the Soviet Union

We must now acknowledge that the Soviet Union, within a few decades of agonizing turmoil, has emerged on the world scene as the mightiest competitor of the United States. This position is based not only on military power and political aggressiveness, but on industrial and economic strength as well. Blood, sweat, tears, and abundant resources have been poured into this attainment, but equally impressive is the special emphasis placed on the crucial role of brain power. Some 12 per cent of the Soviet budget is channeled into the education of its people.

It appears that the principal objective of education in the Soviet Union is to maximize the usefulness of the individual to the State. Consequently, the government is justified in allotting huge sums of money for enhancing the talents of its citizens. In other words, education is regarded as a realistic capital investment. At the same time, a long view is taken in this educational objective: abstract mathematics, basic science, the arts, and body building all fall within the definition of "useful" and play their respective roles in the over-all plan.

If only in the sense that we should learn as much as possible about our competitors to understand more clearly what we are facing, it is well to look open-mindedly at the Soviet educational process. This certainly does not mean that we need admire or copy it, but there may be some deep lessons for us, nevertheless. Knowing the educational system of a country may provide a sensible way of thinking about that country.

Hence, let us consider the various levels of education in the Soviet Union, starting with higher learning and then working back to the grade schools.[1]

Institutions of Higher Learning

There are three types of colleges in the Soviet Union: universities, polytechnic institutes, and professional institutes. Almost all have five-year curricula leading to the first degree (Diploma). However, one does not go to college in the Soviet Union for a general education; there seems to be no liberal arts as such. Each student selects a professional field and the subjects are fixed accordingly.

The University of Moscow is the most impressive example of a Soviet university. The main building is a 32-story structure which stands atop the Lenin Hills overlooking Moscow. There are nearly 24,000 students at this University, including 6,000 evening and special students. The edifice houses not only lecture halls, laboratories, classrooms, and administrative offices, but also 6,000 dormitory rooms. The students are grouped in the living quarters according to their fields of study, presumably to intensify the depth of professionalization. The areas of specialization include history, law, philosophy, economics, oriental studies, mathematics, physics, chemistry, biology, geology, geography, and so on, but not medicine or engineering.

The polytechnic institutes correspond to our institutes of technology, except that the entire emphasis is on engineering, and the students do not major in

[1] For a comprehensive report on the Soviet educational system, the reader is referred to "Education in the U.S.S.R.," Bulletin 1957, No. 14 (1957), U.S. Office of Education; and A. G. Korol, *Soviet Education for Science and Technology* (New York: The Technology Press of M.I.T. and John Wiley and Sons, Inc., 1957).

any of the basic sciences. Diplomas are offered in such fields as mechanical engineering, electrical engineering, building construction, metallurgy, engineering economics, hydrotechnics, radio-technics, and physico-mechanics. The Leningrad Polytechnic Institute is the largest of its kind in the U.S.S.R. and is sometimes referred to as the M.I.T. of the Soviet Union. The enrollment at L.P.I. is twice that at M.I.T. although the number of graduate students is only about 200. Another polytechnic institute I saw was the one at Sverdlovsk in Siberia where the enrollment is also substantially larger than at M.I.T.

The Moscow Steel Institute may be taken as an example of a professional institute. Here, 2,500 students are majoring in ferrous metallurgy, with specialization in such branches as blast furnace, open hearth, electrometallurgy, metallurgical equipment, foundry, physical metallurgy, physical chemistry, and metal physics. Also in Moscow is the Kalinin Institute for Non-Ferrous Metallurgy where 2,000 students are working for degrees in non-ferrous metallurgy and specializing in numerous subdivisions of that field. Thus, there are more students enrolled in metallurgy in the city of Moscow alone than there are in the entire United States. Such technical institutes throughout the U.S.S.R are graduating five to seven times as many metallurgists per year as we do; in fact, they are turning out more female metallurgists than we are male metallurgists! Similar situations undoubtedly prevail in other branches of engineering.

The students pay no tuition or fees when attending institutions of higher learning, and the charge for room and board is only a dollar or two per month.[2] Eighty per cent of the students receive payments from the government for going to college. The stipends amount to $25 to $100 per month and are manipulated by the Ministry of Higher Education to attract students into the various professional fields in the desired numbers. To appreciate the magnitude of these stipends, it may be noted that a laborer can get by with $80 per month for a family of four. There are also many prizes and awards for scholarship.

The incentive system which is so evident in the Soviet education process is actually woven throughout the fabric of that country. When a factory exceeds its production quota, all the personnel from the managing director down to the unskilled laborers share in bonuses, and these increments are set alluringly high compared to the base pay. Hence, there is not only reward for hard work and accomplishment, but everyone feels the pressure from his associates to maintain a stiff pace. Little reliance seems to be placed on the communistic principle that everyone should strive to make his maximum contribution and receive only what he needs in return. The Soviet government now employs wages and rewards, rather than ideals or compulsion, to direct the flow of man power and brain power into the desired channels.

It has been well publicized that the Soviet institutions of higher learning are graduating large numbers of engineers, perhaps two to three times as many per year as in the United States. Of their two million students in college, 60 per cent are seeking degrees in engineering and science. But what about the quality of their training? The quality is good for Soviet purposes. Although the five-year curriculum in any branch of engineering may become quite specialized in the fourth and fifth years, the first three years contain a solid diet of basic and applied science. Professional subjects start in the third year, becoming more and more oriented towards the specialty in the last two years. A thesis and industrial work are required in the curriculum, and the thesis must be defended before an independent commission.

The only nontechnical subjects are a foreign language, economics, Marxism-Leninism (history of the Communist Party), philosophy (dialectical materialism), physical training, and sports. No attempt is made to provide for general education, possibly because the plan of industrial expansion calls for a tremendous number of specialists in pin-pointed tasks. With the great concentration on production of capital goods and heavy equipment, it may take another decade or two before versatility in their engineers will become as remunerative as specialization. After all, the stress on breadth in engineering education now current in the United States only goes back about a generation. There is not the slightest question but that the Soviet government will recognize similar changing requirements in due course and will shift the educational emphasis when necessary.

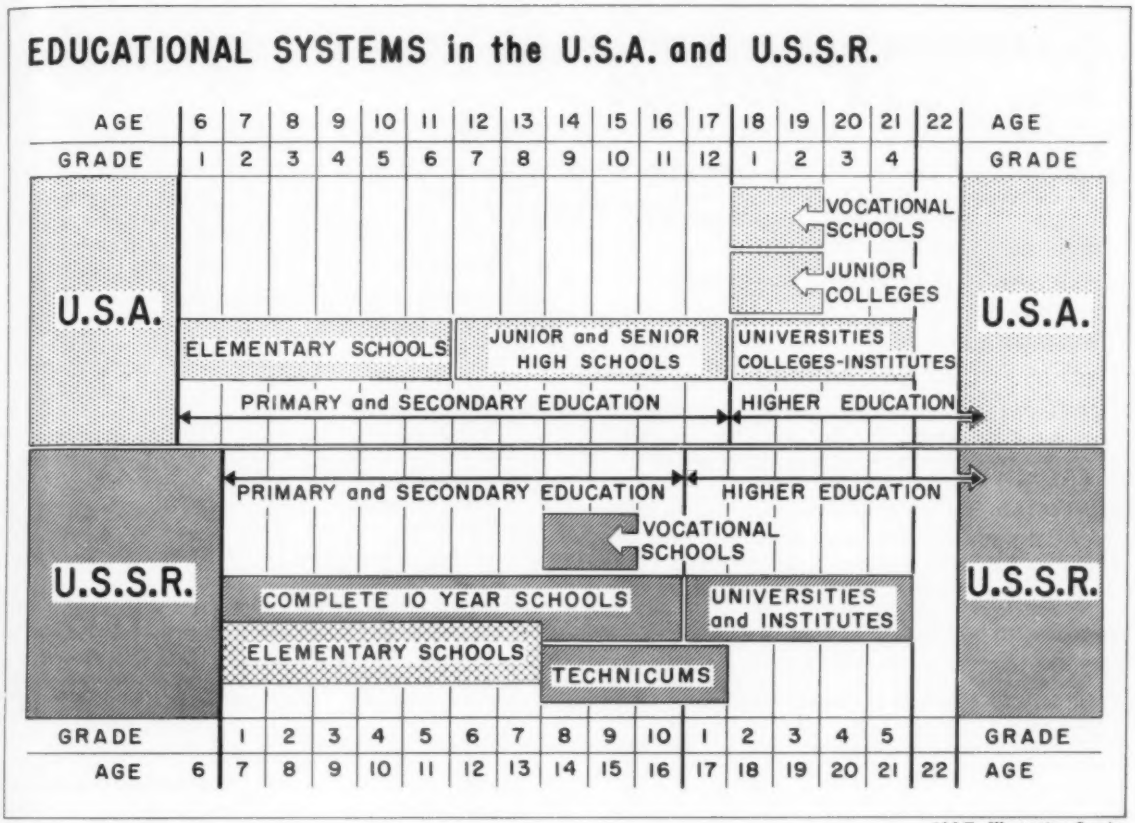
In the meantime, one has only to visit some of the modern plants in the U.S.S.R. to see that their engineers are working with boldness and imagination in the design of equipment and processes, taking advantage of published research with surprisingly little delay. Preoccupation with productivity rather than profit is the order of the day, and the engineers are deriving both national acclaim and personal satisfaction for their accomplishments.

Primary and Secondary Schools

If the Soviet institutions of higher learning can be judged successful by any criterion, much of the credit belongs to the underlying pre-college system. This is where a solid foundation is laid for further education. The Soviets have planned and replanned the educational process many times since the Revolution, but despite violent swings in philosophies and methods, there has evolved an integrated system in which the universities and institutes can now take for granted what the student is supposed to know when he graduates from high school. The grade schools develop the discipline of serious study, drive for scholarly attainment, and respect for authority. At an early age, the youngsters receive powerful doses of mathematics, science, foreign language, and skill subjects. The humanities and social sciences are not neglected either; actually, it is in the pre-college years that the student finds his main exposure to these subjects, although here the substance may be brazenly molded to serve ideological purposes.

The elementary and secondary grades are combined in a 10-year school which may be compared with the American system in Figure 1. Our youngsters start at the age of six and spend 12 years pass-

[2] The dollar figures in this article are based on the tourist exchange of 10 rubles per dollar. This appears to be a more realistic conversion than the official exchange of 4 rubles per dollar.


EDUCATIONAL SYSTEMS in the U.S.A. and U.S.S.R.
AGE 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 AGE
GRADE 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 GRADE
U.S.A.
VOCATIONAL SCHOOLS
JUNIOR COLLEGES
ELEMENTARY SCHOOLS
JUNIOR and SENIOR HIGH SCHOOLS
UNIVERSITIES COLLEGES-INSTITUTES
PRIMARY and SECONDARY EDUCATION
HIGHER EDUCATION
U.S.A.
U.S.S.R.
PRIMARY and SECONDARY EDUCATION
HIGHER EDUCATION
VOCATIONAL SCHOOLS
COMPLETE 10 YEAR SCHOOLS
UNIVERSITIES and INSTITUTES
ELEMENTARY SCHOOLS
TECHNICUMS
U.S.S.R.
GRADE 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 GRADE
AGE 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 AGE

M.I.T. Illustration Service

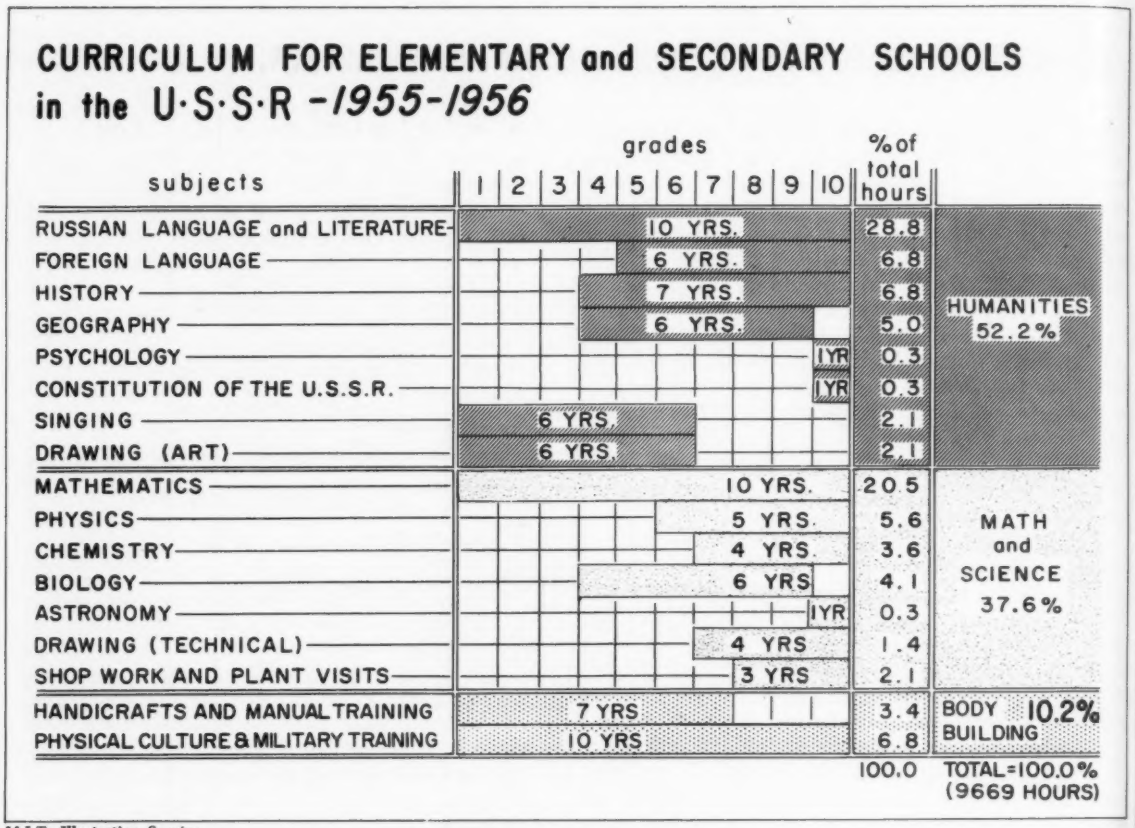
Fig. 1. Comparison of educational systems in the United States and in Russia. Soviet children start to school at age seven, but attend for six days a week and have shorter summer vacation than American children.

ing through the elementary and junior-senior high schools. The Soviet children start at the age of seven and spend only 10 years acquiring their primary and secondary education. In effect, the 10-year school comprises seven years of elementary school and three years of high school. During these 10 years, the pupils attend just as many class hours as ours do in 12 years. This is accomplished by shorter summer vacations and a six-day week. Thus, the Russian youngsters are ready for higher education one year earlier than ours. Then, after a five-year curriculum at the higher level, they graduate at the age of 21 or 22, as do the American students after their customary four-year college course.

Those Soviet children who cannot survive the rigor of the 10-year school may be shunted off into technicums for intense and respectable training at the technician or subprofessional level. Alternatively, they may attend vocational school or labor reserve schools. Tuition is free and the students receive monthly stipends ranging up to $35 per month. The technicums are of particular interest because, through them, the Soviet educational system is generating highly qualified support-personnel for industry, research, medicine, public health, and so on. With such backing, the engineers, scientists, doctors, and other professionals are not only freed from routine duties, but are "pushed up from below" into operations of responsibility and prestige. The Soviet Union is turning out about 10 times as many junior engineers and technicians as we are in the United States. Sixty per cent of the students in the technicums are graduates of the 10-year schools, who cannot or do not go on to college at the time. On graduation from a technicum, the student is permitted to take entrance examinations for higher education if he aspires to become a professional engineer.

The subjects covered in the 10-year school are listed in Figure 2 (page 486). Somewhat over half the curriculum may be classified loosely as "humanities and social sciences." Of special note in this category are the six years of foreign language starting in the fifth grade. Here, there is a choice, and about three-fourths of the pupils elect English. Every 10-year school in the U.S.S.R. offers English as a foreign language, in contrast to only a score of high schools in the U.S.A. that offer Russian. About four-fifths of our high school pupils study no foreign language.

Slightly less than 40 per cent of the 10-year curriculum is devoted to mathematics, science, and technical subjects. The mathematics carries through algebra, solid geometry, and trigonometry to a stage that is reached by less than 10 per cent of our high school students. The five years of physics also stand out in marked contrast to the situation in the United States, wherein about three-fourths of the students take no physics at all. The four years of chemistry required of all students in the Soviet 10-year school are likewise significant, considering that two-thirds of our students study no chemistry at all. Biology,



M.I.T. Illustration Service

Fig. 2. Subjects covered in the 10-year school period in Russia. Of special interest are the six years of foreign language which start for Russian children in the fifth grade.

astronomy, technical drawing, shop work, and plant visits are also part of the Soviet curriculum.

Body building is stressed, too. Approximately one-tenth of the class hours is devoted to the development of manual skills, physical education, and military training, with the latter two subjects being spread throughout the entire 10 years.

The over-all curriculum is intense and rigid. It contains a substantial core of mathematics and science, which has now been well publicized in this country, but the nontechnical subjects constitute an even larger part of the program and are not taught for fun or diversion. Another thought-provoking point is that all the 1.5 million youngsters graduating annually from the Soviet 10-year schools (this is somewhat larger than the annual output of the high schools in the U.S.A.) not only take the subjects shown in Figure 2 but have to pass comprehensive examinations in order to graduate. This emphasis on mathematics and science in these examinations (Figure 3) is astounding when one realizes that all students emanating from the 10-year school system must pass these oral and written tests whether they go on to careers in law, medicine, history, or philosophy, let alone science or engineering! The algebra examination is about equivalent to the advanced mathematics achievement test of our college boards, and the physics test virtually corresponds to the level of freshman college physics in this country.

FINAL EXAMINATIONS FOR GRADUATION FROM THE 10-YEAR SCHOOL IN THE USSR

1.	RUSSIAN LANGUAGE	WRITTEN
2.	RUSSIAN LITERATURE	ORAL
3.	HISTORY	ORAL
4.	ALGEBRA (Corresponds to Advanced Mathematics in College Board Examinations)	ORAL
5.	GEOMETRY AND TRIGONOMETRY	WRITTEN
6.	PHYSICS (Corresponds to Advanced Placement Physics in College Board Examinations)	ORAL
7.	CHEMISTRY	ORAL

M.I.T. Illustration Service

Fig. 3. Emphasis on examinations in mathematics and science is amazing, considering the fact that some Russian students may not even go beyond the 10-year school system.

The sobering fact here is that pre-college education in the Soviet Union is not only providing a substantial base for careers in science and engineering but it is also helping to weave science into the Soviet culture — even for those persons who do not go into technical professions.

The Lesson

The Soviet students are able to absorb a large amount of subject matter and intellectual discipline for two reasons: (1) Excellence in scholarship is respected and sought after as one of the best routes to a life of high income, prestige, and satisfaction. The government recognizes and rewards scholarship

like heroism in battle. Thus, education is not only a privilege for the individual, it is also his obligation to the country. (2) High priority has been given to the enhancement of the teaching profession. The tabulation in Figure 4 shows there are 17 students per teacher in the Soviet Union, compared to a ratio of 27 to one in the United States. Soviet students are attracted to the field of teaching by the well-known capitalistic incentive – money. Figure 5 depicts the average earnings for three vocations in the U.S.S.R. and the U.S.A., in comparison with the wages of laborers in the respective countries. The relative incentives are obvious.

The Soviet Union is apparently solving the problem of mass education without sinking to the level of mediocrity. The scholastic achievements of the 10-year school, notwithstanding the huge number of students that it processes each year, are exceeded only by the very best secondary schools in the United States. Some European countries like France, Germany, and Denmark are noted for the quality of their secondary education; in fact, Czarist Russia also had superb schools but only for the elite. However, it remained for the Soviet Union to demonstrate that the base of its pre-college system could be expanded to match the American magnitudes of quantity, without departing markedly from the European standards of quality. Surely, there is no reason to believe that the Soviet children are any more intelligent or receptive than the American youngsters. Our youth can respond to the intensification of education just as effectively as the Russian children have responded to the spreading of education in their country. Parents and local schools in the United States that expect any less of our children are doing them and their future a major disservice.

The task for America is formidable and complex but not overwhelming. Of course, merely spending more money on education will not solve the problem, but we have been diverting such a small fraction of our wealth and income to education, relatively speaking, that increased expenditures in this direction would be the most tangible step we could take. After all, the 15.7 billion dollars per year that we devote to education in all forms is hardly more than our annual spending for tobacco and liquor. Let us say, for the sake of a target, that our bill for education should be doubled during the next 10 years. This would mean increasing our outlay by 1.5 billion dollars each year until the annual cost for education is 30 billion dollars. It would still be less than the present annual budget for national security, which we would unhesitatingly boost by orders of magnitude if we were faced by a shooting war. We could even afford to be extravagant because we could not afford to do otherwise. On the other hand, the balance of military power presents strong deterrents to war, and although we must be ever alert for this dreadful possibility, to prepare for it alone would be tantamount to relying on a Maginot Line.

The vigorous activity in the Soviet Union at the present time is the Twentieth-Century version of the western gold-rush days in America. The Soviet people have unleashed a hitherto pent-up vitality which has little to do with their particular form of govern-

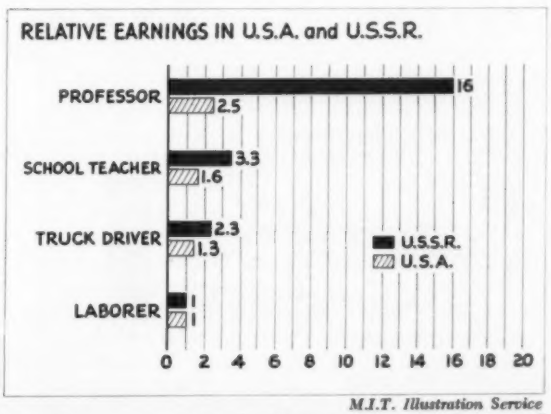
STUDENT-TO-TEACHER RATIO 1955-56	
FRANCE	45 to 1
ENGLAND AND WALES	30 to 1
UNITED STATES	27 to 1
SWEDEN (1951)	22 to 1
SOVIET UNION	17 to 1

M.I.T. Illustration Service

Fig. 4. From the student-to-teacher ratio listed above, the Soviet has 17 students per one teacher, compared to 27 pupils for one teacher in the United States.

ment; but the Communist leaders are receiving the credit and they have much to gain by keeping the peace. Having attained a position of military strength and stalemate, they anticipate that the real competition of the future will be political, technological, and economic, to align the uncommitted nations which now comprise about one-third of the earth's population and area. The stakes are enormous in view of the fact that the rest of the globe is now divided almost equally between N.A.T.O. and the Western countries on the one hand and the Communist bloc on the other.

Any such struggle for the orbitizing of uncommitted nations will go on in the minds and hearts of men, and we will not meet it with any degree of sophistication unless we acknowledge the crucial part that is to be played by education. In the not-too-distant future, we as a nation may have to choose from among three courses of action. We may decide to enter that competition, and if so, we shall certainly want to maximize our potential for success. Or, if we elect not to enter the competition, we shall want to turn away with the conviction that our supreme goals lie in other directions. Or, we may reconcile ourselves towards finding a way of working together with the Soviet Union. Not only will enlightenment, wisdom, and understanding be required



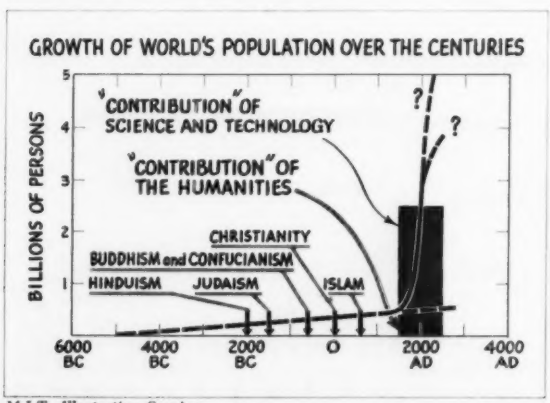
M.I.T. Illustration Service

Fig. 5. Average earnings for three vocations in the United States and in Russia, compared to wages of laborers.

of us to decide on the best path for the future, but those attributes will also be essential to ply successfully along the path that we choose. And fundamental to all this will be the education of our children to their utmost capacity.

In all probability, the U.S.A. and the U.S.S.R. will one day move into the third alternative and face the compelling need to live together. There will then be a kind of complementarity on a grand scale in which the newly acquired ground rules will seem unnatural to both sides for a while. However, both peoples will ultimately realize that their "facts" and "common sense" are not absolute and permanent, but actually depend upon their respective viewpoints as observers. Perhaps there is a lesson in the composure of the scientist who lives interchangeably with the particle theory of light on Mondays, Wednesdays, and Fridays, and with the wave theory of light on Tuesdays, Thursdays, and Saturdays, adopting each as necessary for the best insight into nature—yet without becoming frustrated about the change-overs.

If this globe were endangered by an invasion from space, the nations of the earth, including the U.S.A. and the U.S.S.R., would surely join in common brotherhood to defend the world. We would then find that the two peoples have much in common of greater substance than that which separates them. Threat of a world-wide plague could likewise bring us together. As an alternative then, when shall we have the imagination, the courage, and the educational maturity to devise our own methods for achieving some basis of co-operation? Scientific projects would seem to offer the optimum basis for breaking the ice. Think of how the hopes of the the world would be stirred if the United States and the Soviet Union combined their technical forces to launch a space ship to the moon! Or, if the moon has already become a cosmic football because each country wants vested interests there, what about forming a partnership to land on one of the planets; why wait for Martians to invade the earth? Conceivably, such a co-operative venture by the U.S.A. and the U.S.S.R. in the realm of science and technology could pave the way for establishing more compatible ground rules on earth!



M.I.T. Illustration Service

Fig. 6. Growth of the world's population, particularly since the impact of science and technology on man and the beginning of the industrial age.

In the intensified process of general education that we are discussing for America, there must be a substantial component of science, for the spectrum of total knowledge is expanding almost explosively due to science and technology. The conventional liberal education will not be "liberal" in the future if it does not contain science subjects in its very core. These should be serious subjects; the science-can-be-fun motivation is hardly adequate. We are not dwelling here on the need for educating the large number of scientists and engineers who will have to solve the tehcnical problems lying ahead. Sooner or later, these challenges will become so urgent that our society will provide the incentives to attract enough students into the relevant professions. But any society is doomed if it tries to take the inexpensive way out by simply hiring scientists and engineers as mercenaries to split the atoms and keep the wheels turning. A more profound educational approach is required in which scientific analysis becomes a part of the thought processes of the people.

The impact of science and technology on the very existence of humanity has been graphically portrayed by Lawrence Hafstad[3] in the world's population curve of Figure 6[4]. For most of recorded history, the population of the earth has grown at a modest rate despite the rise and fall of civilizations, war and famine, and the concomitant emergence of government, law, trade, art, literature, and religion. The sweep of the time scale in Figure 6 is pointed up by the starting dates of the world's great religions. Suddenly, almost three centuries ago, the population began to increase cataclysmically, undoubtedly as a result of the impact of science and technology and the entrée of the industrial age. The detailed nature of these interactions, even to the undeveloped corners of the earth, has been lucidly described by Harrison Brown[4]. There seems to be a natural urge for man to cling to life, and almost instinctively he has groped his way to take advantage of (and hence become dependent on) the life-sustaining benefits of science and its applications. There is no turning back, for as the population continues to skyrocket, mankind will become evermore reliant upon new sources of food and energy, transportation and communication, machines and instruments, antibiotics and sanitation, and all the other products of a technological civilization.

If America is to play a prominent role in meeting these needs without becoming a slave to them, the importance of general education with an appropriate content of science takes on new dimensions. It becomes evident that intellectual power is no less vital than horsepower. We must now have the will and the foresight to direct a larger fraction of our wealth into the simulation of mental pursuits even at the expense of comforts and conveniences. Quite likely, this effort will entail a retarded advance in our material living standards, but in return it will nourish a taste for finer things that will ultimately give

(*Concluded on page 508*)

[3] Lawrence R. Hafstad, "Science, Technology, and Society," *The Technology Review*, **60**:111 (December, 1957).

[4] Harrison Brown, *The Challenge of Man's Future*, page 49 (New York: The Viking Press, 1954).

RESEARCH IN
Undergraduate Engineering Education

As undergraduate training in engineering becomes progressively more scientific, stronger programs for engineering instruction are being developed

SYMPOSIUM ADDRESS by EDWIN R. GILLILAND

PROFESSOR MORRIS COHEN ['33] has described the educational program of the Soviet Union. I will discuss with you a study now going on at M.I.T. relative to our own engineering education. First, because of the sequence of these talks, I would like to make it clear that the study of the Committee on Engineering Education is in no way related to the Russian situation. The committee was appointed by Dean Soderberg at least a year before the Sputniks were launched, and the Russian efforts have not influenced our deliberations. We are considering what can be done to improve undergraduate engineering education at M.I.T.

We believe that M.I.T. has had and does have a very good program in engineering education. Just looking at what you and other Alumni have accomplished convinces us that the program has been good. We are immodest enough to believe that at least a part of the success of our graduates is related to the training they received while at M.I.T. However, we know that the program can be improved, and it can be much better. Those of us who have been teachers for a long time realize how much more could be accomplished if we could only keep the students excited about their work. Today, as I am sure it was in your day, we have good students; but if we could fire their enthusiasm, their accomplishments and their potential could be greatly increased. I have just finished grading final examinations, and this always is a discouraging task. It very forcibly shows you how little of the real potential of your students you have been able to develop. We need to develop programs, methods, systems that will do this more effectively.

The fact that the program has been good in the past is one of our difficulties. The present study of our educational program is not new. This is almost a continuous process at M.I.T. After the war, the President appointed the Educational Survey Committee, and this group spent several years analyzing the problems of our undergraduate education. On the basis of their results, a new committee structure was formed and committees were appointed for a continuous study of the undergraduate educational policy. In addition to these analyses, a few years ago there was a committee under the leadership of Professor Gordon S. Brown ['31], Head of the Electrical Engineering Department, which looked at our educational work in the engineering field. You may ask, with all this study, why do we have another committee? We also ask ourselves the same question. But I believe that our justification is in the fact that even with all these studies, we find that our program is very much the same as it was in the past, and we are confident that it should be improved. As a result of these studies and of studies by other non-M.I.T. groups, there have been many suggestions of changes that might improve the program, that might increase the motivation of the student, that might increase the motivation of the staff; but to date, no one has come up with any suggestion which is so obviously better than what we are doing at present that the Faculty as a whole will become enthusiastic over it. Without almost unanimous enthusiasm, a new program will not be successful. This difficulty in finding universal enthusiasm is not surprising in view of the long development of our present system. What we are attempting to do is to improve on a good and tested program.

I do not know of a single program that I believe would obtain or should obtain the enthusiastic support of our entire Faculty. Each of the many suggestions has potential advantages and potential disadvantages. Each has its advocates and those who are less enthusiastic. Our committee has come to the conclusion that the best way to improve undergraduate engineering education at M.I.T. is to encourage the enthusiasts to carry out their experiments. We believe that M.I.T. can give real leadership in this field by encouraging groups of its staff to do significant experiments in engineering education. We believe that the Institute should boldly undertake new experiments in education. We believe that the enthusiasm generated by such an experiment is a benefit in itself, and the enthusiasm of the staff creates enthusiasm in the students, and that this alone is worth obtaining; that in addition, such experiments will appeal to many of the students. We are not proposing that the whole Engineering School change its program, but are trying to encourage individual departments and groups of the Faculty to make studies and experiments more frequently than has been done in the past. We would like to adapt the techniques that have been so successful in our scientific work to our educational program. We need to do research in education. Such experimentation at

the departmental level is not new at M.I.T., but we would like to encourage and increase the frequency of such tests.

Before discussing some of the experiments we are considering, let me take a few minutes to describe what we believe is the objective of the undergraduate engineering program at M.I.T. The committee considered whether M.I.T. should have an undergraduate program in engineering. We are unanimous in our conviction that such a program is desirable, and that it should be continued. The Educational Survey Committee gave as its opinion that the objective of undergraduate training in engineering at M.I.T. was the development in the individual of the ability to handle new and unfamiliar problems with competence. We agree with this objective, but would like to make it a little more specific. We would like to see the objective as the development of each individual to his full potential by (1) a sound general education, (2) a thorough training in basic and applied sciences, (3) the development of intelligent judgment in the application of scientific principles to complex problems, and (4) an understanding of the methods needed to create new knowledge. We have a real opportunity, with the type of students we have, to make an outstanding contribution to the whole country if we can come closer to obtaining these objectives.

M.I.T. should operate an educational research laboratory or pilot plant. We have many "processes" we would like to evaluate. One of these, which we have given a major study, is termed "engineering sciences." The engineering sciences are those scientific areas taught in the Engineering School whose subject area is essentially common to all branches of engineering. For example, we consider thermodynamics, statics and dynamics, properties of materials, fluid dynamics, rate processes, electrical phenomena, as examples of this type. At M.I.T., some of these are given by a single department for engineering students, while in other cases, several departments give instruction. When the time spent on these subjects is added to that in the basic sciences and in the humanities, it accounts for a high percentage of the total program for undergraduate students in engineering; and there are those who believe that there should be only a single, general undergraduate program in engineering rather than the various departmental programs that are common today. This idea has certain attractions. It also has many obvious disadvantages. We have examined this carefully and do not believe that this is the best arrangement at the present time.

Participating in the Alumni Day symposium were, in usual reading order: Morris Cohen, '33, Professor of Physical Metallurgy; Gilbert M. Roddy, '31, President of the Alumni Association; Holt Ashley, '48, Associate Professor of Aeronautical Engineering; and Edwin R. Gilliland, '33, Professor of Chemical Engineering.

Training in undergraduate engineering in the United States will progressively become more and more scientific. The scientific content of the program will be increased and the professional aspects deferred until the graduate years. This does not mean that we believe all students should continue for graduate work. We believe there are large groups of our undergraduates who will make their greatest contribution by taking their bachelor's degrees and going into industry. Some of these will obtain professional training from the industrial companies; but many of them will choose to go into a phase of industry in which highly specialized engineering training is not necessary, but in which a basic, broad, rigorous scientific training is very beneficial. Others of our students will be the leaders in their professional field. They will make the technical contributions of the future. In general, these men will continue for graduate study; and for this latter group, a basic foundation in science with a broad program of engineering sciences would give them a superb background for their graduate specialization.

Our real problem is, how should a stronger engineering science program be introduced at M.I.T.? We are convinced that the whole Engineering School should not be so converted. But should we have simply an additional course which could be selected by those students who were attracted and motivated by this type of program, should we have a new Department of Engineering Sciences or Applied Sciences, or should each department give the student the option of taking either an engineering science type of program or a more professional sequence? We have concluded that this is a major problem and that it requires serious study by the Faculty. We have suggested that in each of these areas we should establish a group of the Faculty, with representation of each of the engineering departments, to make a detailed study of what should be done. Should we have a common course for all the students taking this particular subject; and if we should, what should such a course involve? We believe that such studies will have very great benefit. They will bring groups together which will make penetrating studies that will include the viewpoints of all the departments. As a result, the Faculty as a whole will be able to learn just what would be done if we had such common subjects. They will be able to decide whether such a program would be good for all of our students, or for only a limited few, or for none. As a result of these studies, the individual members will carry back a viewpoint that will improve the courses given by the departments. We feel confident it will be a major benefit.

During the coming summer, we are beginning two such studies. Professor Ascher H. Shapiro ['38] of the Mechanical Engineering Department is heading a group of the staff which will look broadly and in detail at the engineering science problem to formulate

(Continued on page 528)

Astronautics—

A CHALLENGE IN ENGINEERING EDUCATION

The most successful way to educate engineers capitalizes on the natural motivations and enthusiasms of students

SYMPOSIUM ADDRESS **by HOLT ASHLEY**

LET me begin my talk by stating three articles of faith, arrived at through a continuing process of discussion, trial, and educational experimentation by the faculty of the Department of Aeronautical Engineering:

1. We believe that a sound engineering education, regardless of its length in years, has four principal interrelated elements. There are: (a) basic and applied science; (b) general education in the humanities; (c) engineering science; and (d) professional engineering activity. All this is needed for the greatest good of the individual and the society in which he will work; no element can safely be omitted.

2. We believe we have a responsibility to establish habits of thought which engender intelligent judgment in the application of scientific principles to the solution of complex problems, involving the synthesis of many disciplines and finely balanced engineering compromises.

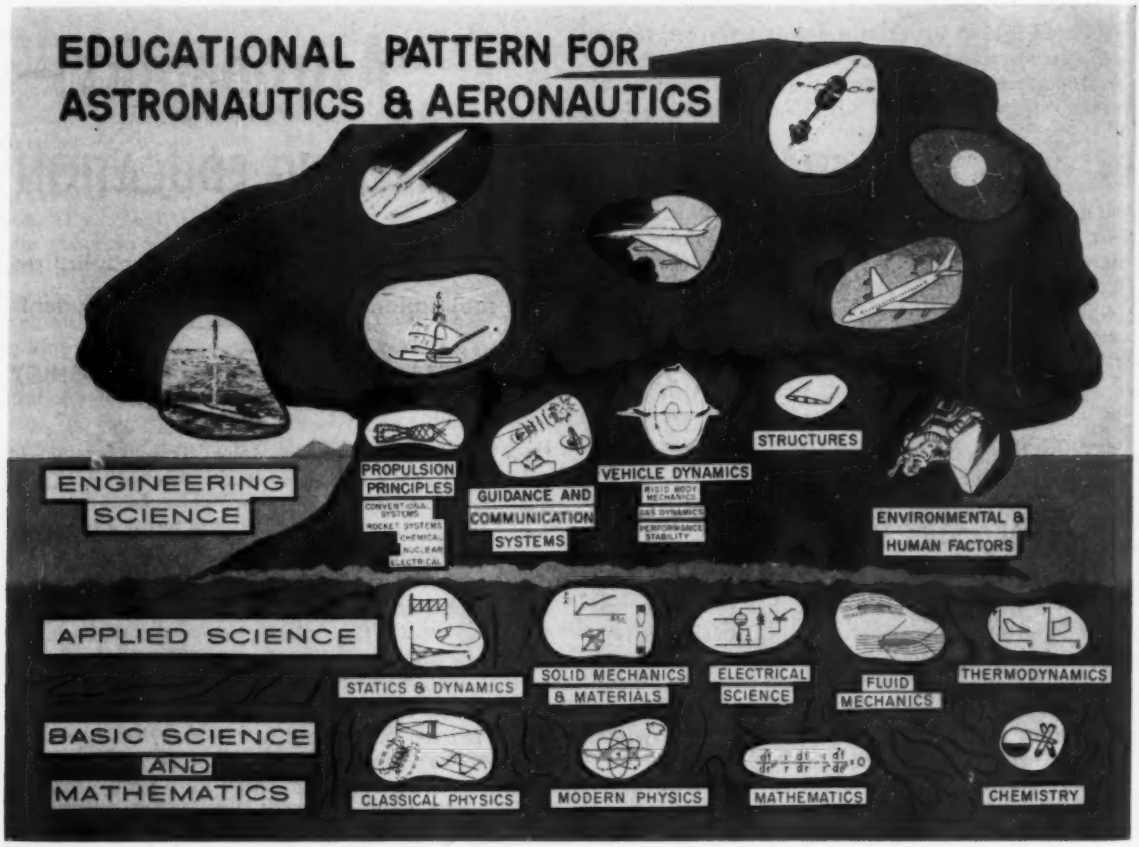
3. We believe that this sort of preparation will be equally suitable for careers in applied scientific research or professional engineering. But to achieve it, the subject matter must be carefully integrated, and taught by a faculty which contains both scientists and practicing representatives of the engineering profession. The M.I.T. School of Engineering today is endowed fortunately with just such a faculty.

Where does astronautics fit into this pattern? The answer lies in the key word "motivation." The American undergraduate student of technology is a peculiar animal, unrecognizable to educators in the classical European tradition. You can expose him to the same fact or concept a dozen times, and if he does not comprehend what it is for, he will forget it. But show him once where that fact fits into the operation of a long-range radar, or a nuclear rocket, or a satellite space station and he will remember it forever. This is our answer to the intense emphasis on intellectual enhancement in the U.S.S.R.

Students with unquenchable enthusiasm are knocking down the doors of the School of Engineering—and the School of Science. In the particular areas of high-speed flight, space travel, and astronautics we can see their influx with unusual clarity. Two years ago the graduating group in Aeronautical Engineering made up about 5 per cent of the Class of 1956. Today some 9-11 per cent of each entering class indicate a preference for aeronautical and astronautical engineering, and almost every one of their application forms contains some reference to an interest in space. But most of these boys and girls share some delightful illusions. They do not realize that to work in this field they must know a lot about partial differential equations, the wave function of quantum physics, Hamilton's principle of dynamics, nonequilibrium thermodynamics, chemical kinetics. How can we use their motivation as the springboard over such hurdles to their own ultimate success and to the promotion of the welfare of the free world? A partial or tentative answer may be in the educational pattern developing within the Department of Aeronautical Engineering. If you like, it is one of the "educational experiments" to which Professor [Edwin R.] Gilliland ['23] has just referred. The remainder of my talk attempts in brief to outline this experiment.

Figure 1 describes the framework within which we try to operate. The foundations, the roots of the tree, are in the aforementioned basic and applied sciences. Some of these are far better taught by the mathematicians, physicists, and chemists who can give engineering students at least a colorful glimpse of current research activities in their own fields. Others are taught by engineers, drawing heavily on the motivation potential of examples from modern engineering problems. "Engineering science," the trunk of the tree, we cover almost entirely within our own Department. We must deal in quantitative terms with nonrigid bodies moving at high rates of speed under the action of enormous forces, subject to critical strength-to-weight requirements, having no practical use unless high performance is achieved. To meet the associated requirements, the essential background in dynamics, structural analysis, propulsion, guidance and communications, and fluid mechanics takes considerably more time and effort than for some other fields of engineering.

All of this preparation leads us to the branches of the tree. There, under the heading of professional engineering, every student has the chance to try his wings on a thorough, detailed project having to do with one or more of the devices illustrated in the figure. Most of my audience would never recognize the senior and graduate "drafting rooms," as they are sometimes miscalled. Here every day the Nyquist criterion is being applied to study the stability of an automatic control system; nonlinear theory of elasticity goes into the structural analysis of thin shells;



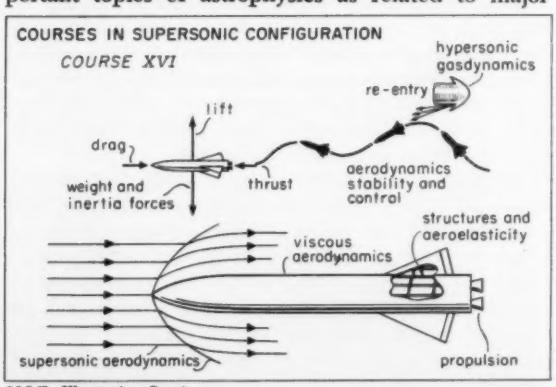
M.I.T. Illustration Service

Fig. 1. Areas of knowledge with which the Department of Aeronautical Engineering is concerned, showing how specialized professional projects are rooted in basic science and engineering knowledge.

the calculus of variations is used to compute optimum trajectories of missiles and space vehicles. There is not a handbook within 500 feet; the publishers discovered that they become obsolete too fast. Furthermore, they constitute a dangerous accident hazard; if a handbook suitable for designing a simple air-borne vehicle fell off a desk, it could break someone's leg.

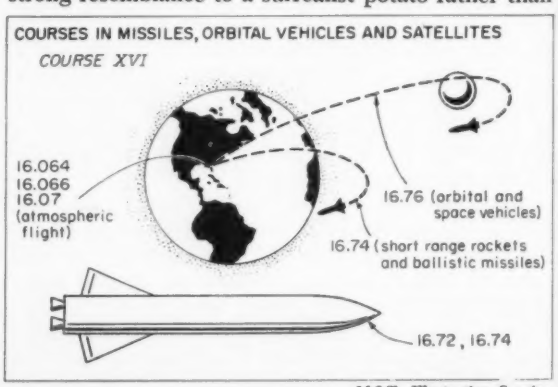
Figure 2 illustrates how the engineering science topics are tied in for the student with various aspects of vehicle flight within the earth's atmosphere. In this illustration we see portrayed a number of important topics of astrophysics as related to major courses of study as given in the Department of Aeronautical Engineering. The purpose of this diagram is merely to illustrate the correlation between modern engineering problems and areas of study that contribute to a solution of such problems. But we have tried to indicate this correlation in an interesting way.

Too often, especially in our undergraduate work, the motivation stimulation is entirely lacking in the textbooks from which the students study. The static equilibrium of rigid bodies, for example, is often represented by means of a diagram that bears a strong resemblance to a surrealist potato rather than



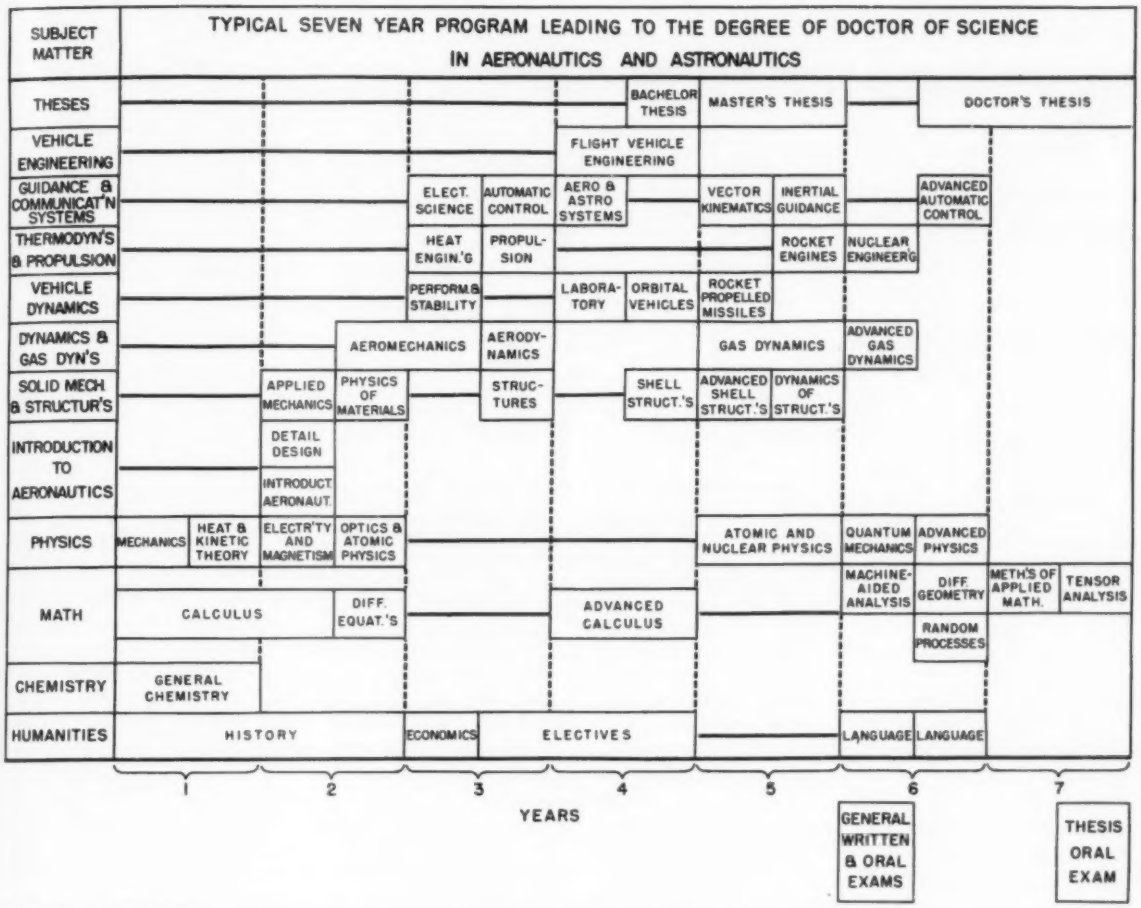
M.I.T. Illustration Service

Fig. 2. Topics in engineering sciences which deal with vehicular flight in the earth's surface.



M.I.T. Illustration Service

Fig. 3. Topics of instruction given at M.I.T. contributing to preparation of astronautical engineer.



M.I.T. Illustration Service

Fig. 5. Typical programs in aeronautics and astronautics leading to degrees of bachelor of science, master of science, aeronautical engineer, and doctor of science.

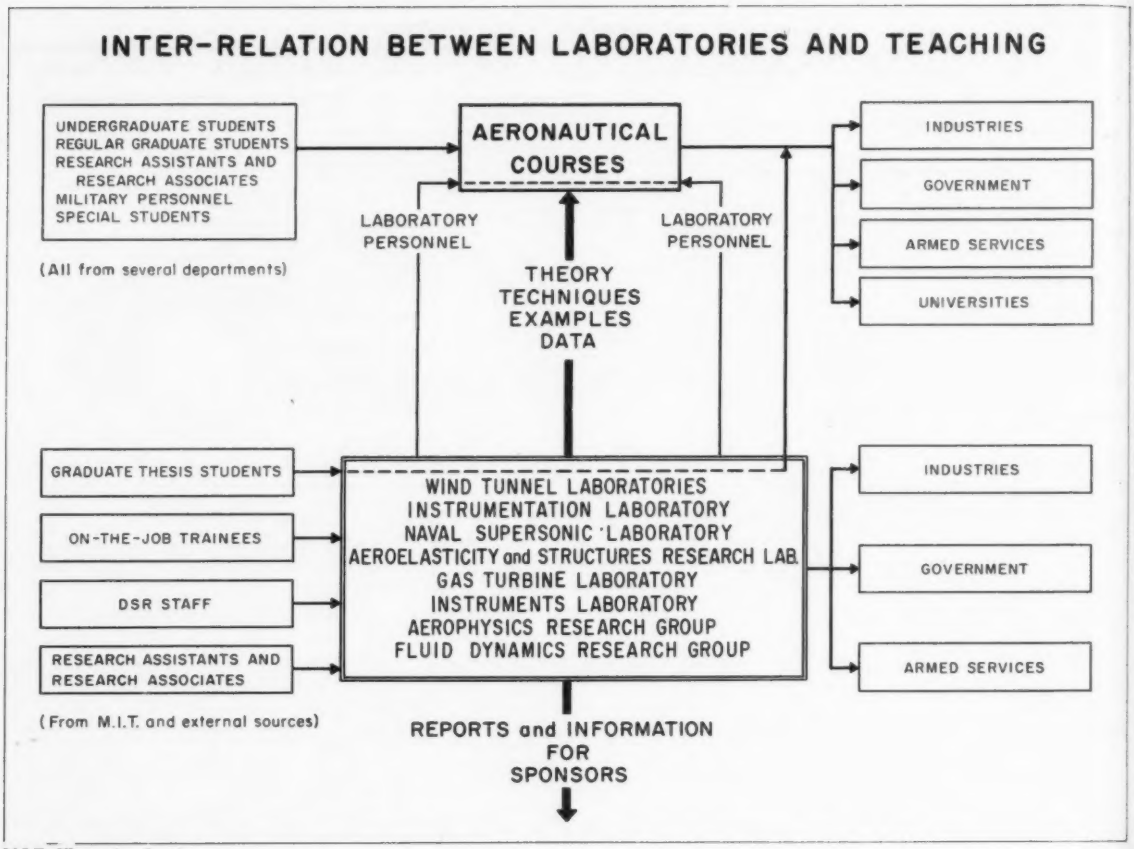
to any practical problem of engineering in science. Of course, such a diagram is intended to indicate the generality of the analytical method under discussion. But there is no reason why principles could not be illustrated by means of diagrams that illustrate principles – and do so by stimulating the student to think in terms of practical applications that are of the utmost importance to him. It has been our experience that the student quickly grasps the principles and can apply them to other problems when he is confronted by them.

COURSES DEALING WITH ASTRONAUTICS	
16.00	FLIGHT MECHANICS
16.064	THERMAL EFFECTS
16.066	HYPERSONICS AND SUPERAERODYNAMICS
16.07	AERODYNAMICS AND DYNAMICS OF MISSILES
16.392	ORBITAL VEHICLES
16.40	AUTOMATIC CONTROL OF AIRCRAFT AND MISSILES
16.47	ROCKET PROPELLED MISSILES
16.60	DESIGN OF LIQUID AND SOLID PROPELLANT ROCKETS
16.72	AERONAUTICAL ENGINEERING - MISSILE PROGRAM
16.74	ADVANCED (MISSILE) DESIGN
16.76	ORBITAL VEHICLES

M.I.T. Illustration Service

Fig. 4. Selected group of courses given at M.I.T. relating to astronautics. The list is by no means complete.

Figure 3 shows the topics of instruction now given within the Department of Aeronautical Engineering which contribute to the preparation of the astronautical engineer, and which are being used right now by many students in and out of the Department for just this purpose. The list of these subjects (Fig. 4) is by no means complete. There are gaps in such areas as astronomy, celestial mechanics, nuclear engineering, and space medicine. Some can be filled now or from subjects taught in other departments, but here at least is a beginning, and our students recognized it as such almost before we did. It is significant that Orbital Vehicles was first offered in 1953 by a faculty group ably headed by Paul E. Sandorff, '39, Associate Professor of Aeronautical Engineering. It had a registration of nearly 40 that first year. It has steadily grown and has attracted registrants from nearly every department in the Institute. This is desirable in itself, for it indicates as nothing else can, how interdependent are the various areas of knowledge which today's engineer and scientist must comprehend if he is to take his proper place as a leader in the practice of his profession. But from the point of view of the Department of Aeronautical Engineering, we were even more impressed with the caliber of the students registered in the course in Orbital Vehicles. Later classes included not only students in our own Department,



M.I.T. Illustration Service

Fig. 6. Relationships between teaching and research in the Department of Aeronautical Engineering.

but instructors and professors from other departments. The latter were men who attained competence in their own field, but were anxious to extend their learning and understanding into new areas so that their own work could become more significant and meaningful.

Figure 5 presents a typical program in aeronautical and astronautical engineering which has been laid out by the faculty primarily from subjects already being given. For five, six, or seven years of study, the programs illustrated in Fig. 5 lead to the S.M., A.E., and Sc.D. degrees.

It is significant that such programs draw on material taught in a dozen departments throughout the Schools of Science and of Engineering, as one would certainly expect of an "interdisciplinary" field like astronautics. Fortunately space vehicles represent a natural evolution of the light, very fast, complex devices which have been the concern of the aeronautical engineer, so that the course on Orbital Vehicles provides a ready-made, flexible framework around which the educational challenge can be met.

Figure 6 describes one final factor which we regard as essential to success in all the objectives I have outlined. This is the intimate relationship which exists between teaching and research at all levels in the Department. The research activities of our faculty and staff are manifold and far-reaching, especially in the fields of automatic control, aerodynamics, structures, and jet propulsion. Day by day all of our subjects of instruction, from sophomore aeromechanics to advanced graduate theory of hypersonic flow, draw on the research experience of the eight departmental laboratories. Undergraduates by the score and almost every graduate student in the Department find part-time employment in these laboratories, helping to ease their all-too-severe financial problems while seeing the principles they have learned being put to work. We are proud of the intense, continuing effort that is made to integrate teaching and research. It represents a first step in reinforcing the enthusiasm of the "space boy" by the more mature motivation of solving real, quantitative problems that daily face the aeronautical and the astronautical engineer.

Let me close with one thought: there is no single way to educate an engineer, just as surely as no one man can now compass all the fields of engineering. But the most successful ways are sure to be those which capitalize on the natural motivations and enthusiasms of students. If this can be done successfully – while providing balanced preparation in basic and applied science, general education, engineering science, and professional activity – then with the enormous reservoir of talent which we have to draw on in America today, we need have no fear that the engineering profession will fail to meet *any* of the multiple challenges of the fascinating future.

Reunion in Cambridge

Commencement comes as school year ends and "grads" return to make new friends

A TECHNOLOGY REVIEW REPORT

As a new crop of graduates takes its place to right the world's wrongs each spring, educational institutions all over the nation re-enact commencement exercises and play host to former graduates who return to their alma mater for periodic reunions. Despite their brilliant pageantry, there is something old and familiar about commencement ceremonies and alumni reunions. Yet each, in its own way, is a unique event.

So it was with reunion in Cambridge this year, with commencement exercises at M.I.T. on Friday, June 13, and Alumni Day on Monday, June 16. On both days the sky was clear, but brisk winds prevailed and canvas tents erected for the events were most welcome.

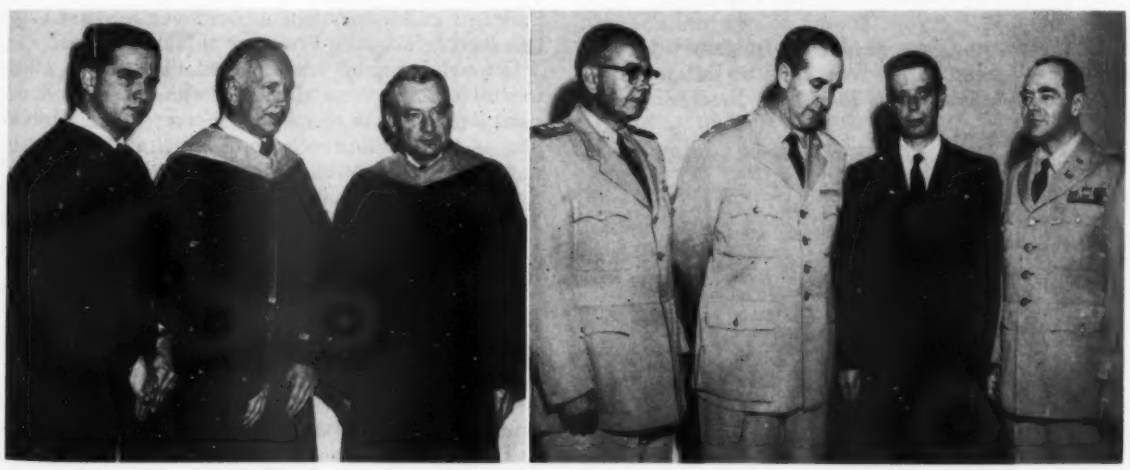
This year the Institute graduated 1,112 young men and women who received a total of 1,191 degrees. As has been the trend since the end of World War II, the Institute's graduate student body continues to increase percentagewise as well as in absolute numbers. This year 508 advanced degrees were awarded, representing almost 42 per cent of all degrees awarded. Further statistical information appears on page 499.

Alumni Day, 1958, was marked by serious concern for the nation's educational program. The morning symposium had for its theme "Education for a Changing World." At the luncheon, James R. Killian, Jr., '26, Special Advisor to President Eisenhower on Science and Technology, spoke on "Maintaining the Strength of U. S. Technology." In reporting to Alumni regarding the year at M.I.T., Acting President J. A. Stratton, '23, emphasized the progress being made in assuring that modern engineering education fills the needs of a technological society.

Senior Week Events

Senior Week ushered in a round of highly organized social events which culminated, for the graduates, with commencement exercises on Friday, June 13, and brought "old grads" back to the Institute on Alumni Day, Monday, June 16. The social events of Senior Week provided the last opportunity for the Class of 1958 to review and reminisce – in full strength – their years of study in Cambridge before taking up their responsibilities as professional participants in the world's work.

Acting President Stratton was the honored guest at the Senior Class Banquet, held in Rockwell Cage on the evening of Friday, June 6. The following evening, Saturday, June 7, members of the graduating class attended Symphony Hall where Arthur Fiedler con-



(Left) *Photographed in the Green Room of Kresge Auditorium just prior to the baccalaureate service are, in usual reading order: Robert E. Jordan, 3d, President of the Senior Class, who gave the Scripture reading; Chancellor Julius A. Stratton, '23, who gave the invocation; and Dean Harold L. Hazen, '24, who delivered the baccalaureate address reproduced on page 471.* (Right) *Those taking part in the R.O.T.C. commissioning exercises on June 12 were, from left to right: Admiral William E. Howard, Jr., '33; General Walter C. Sweeney, Jr.; General James McCormack, Jr., '37, Vice-president of the Institute; and General Alden K. Sibley.*

Following commencement exercises, an informal luncheon was held in the Great and Du Pont Courts. Head table guests were (left to right): *Evers Burtner, '15, Associate Professor of Naval Architecture and Marine Engineering, who retires as of July 1; Mrs. L. F. Hamilton; John J. Wilson, '29, President-elect of the Alumni Association; The Very Reverend Monsignor Francis J. Lally; Mrs. Vannevar Bush; H. Leston Carter, '08; Mrs. J. A. Stratton; James R. Killian, Jr., '26; Julius A. Stratton, '23; Vannevar Bush, '16; Mrs. J. R. Killian, Jr.; John J. McCloy, commencement speaker; Mrs. J. J. Wilson; Russell E. Walstedt, '58; Mrs. Evers Burtner; and Leicester F. Hamilton, '14, Professor of Analytical Chemistry, who retires as of July 1.*

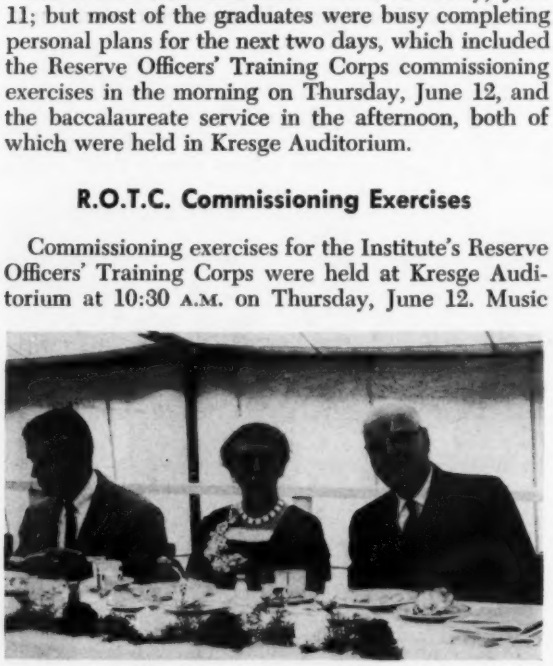
ducted the Boston Pops Orchestra. Perhaps sentimentally inclined persons could find nostalgic significance in the published program whose last three numbers were: "June is Bustin' Out All Over," "Smoke Gets in Your Eyes," and "When Johnny Comes Marching Home."

On Sunday, June 8, Rowe's Wharf was the point of departure for those who chose to take a moonlight cruise around Boston Harbor, and a "Mystery Night" dance was held at Baker House on Monday, June 9. In somewhat more formal manner, the Annual Commencement Formal Ball was held on Tuesday, June 10, at the Bradford Hotel in Boston.

No events were scheduled for Wednesday, June 11; but most of the graduates were busy completing personal plans for the next two days, which included the Reserve Officers' Training Corps commissioning exercises in the morning on Thursday, June 12, and the baccalaureate service in the afternoon, both of which were held in Kresge Auditorium.

R.O.T.C. Commissioning Exercises

Commissioning exercises for the Institute's Reserve Officers' Training Corps were held at Kresge Auditorium at 10:30 A.M. on Thursday, June 12. Music was provided by the Needham High School Band, whose excellent performance matched that of previous years in which it has had a stirring role in M.I.T. military exercises. The ceremonies were opened with an invocation offered by Rabbi Herman Pollack, Religious Counselor at M.I.T. Greetings and welcome were extended to the assembled guests by Major General James McCormack, Jr., '37, Vice-president of the Institute, on behalf of President Killian, the M.I.T. Corporation, and the Institute Faculty.



A closer view of the right-hand end of the table, above, showing R. E. Walstedt, '58; Mrs. Evers Burtner; and L. F. Hamilton, scheduled to retire July 1. Members of the Tranquility Club at Walton's Restaurant (where the elite meet to beat the heat) are giving heavy odds that July 1 will make no difference in the schedule of the executive officer of the Department of Chemistry.

General McCormack also introduced the guest speakers representing the three branches of the nation's military service: Major General Walter C. Sweeney, Jr., Commanding General of the Eighth Air Force, Westover Air Force Base; Rear Admiral William E. Howard, Jr., '33, Commander, Boston Naval Shipyard; and Brigadier General Alden K. Sibley, Division Engineer, United States Army Corps of Engineers.

Representatives of the Armed Forces stationed at M.I.T. are: Colonel Harmon Lampley, Jr., Professor of Air Science; Colonel Gilbert G. Brinckerhoff, Jr., Professor of Military Science and Tactics; and Captain Joseph S. Lewis, Professor of Naval Science.

Colonel Lampley administered the oath of office to students who were about to receive their commissions as officers in the Armed Forces of the United States. Presentation of commissions was made to newly created officers of the Air Force by General Sweeney and to officers of the Army by General Sibley. The Naval R.O.T.C. unit was organized at M.I.T. only two years ago and has not had opportunity to award commissions.

Those commissioned at the exercises numbered 110 in all. The United States Army awarded commissions as follows: Corps of Engineers, 15; Signal Corps, 12; Ordnance Corps, 25; Chemical Corps, 24; Quartermaster Corps, 13. The United States Air Force awarded 21 commissions.

The ceremonies were concluded as the Needham High School Band played the "Star Spangled Banner," and the Reverend Robert C. Holtzapple, Jr., Religious Counselor at M.I.T., gave the benediction. After that, it remained only for the cadets to pin their bars on their shoulders and leave Kresge Auditorium with a new sense of responsibility.

Facing the camera, those greeting graduates and their guests on June 13 were: Dr. and Mrs. Killian; Dr. and Mrs. Stratton, barely visible; Dean John T. Rule, '21; Mrs. and Dean Frederick G. Fassett, Jr.; and Robert E. Jordan, 3d, '58.

Baccalaureate Service

Members of the graduating class, who had previously assembled in a double column in Briggs Field west of Kresge Auditorium, took their seats in the splendid auditorium at 3:00 P.M. on Thursday, June 12, for the baccalaureate service.

In the prelude, David Johnson at the Holtkamp organ played selections by Bach, Vaughn Williams, Buxtehude, and Franck. Members of the class filed in to Mr. Johnson's rendition of Richard Strauss's Festival Processional and Handel's Solemn Processional from the "Water Music Suite."

Acting President Stratton opened the services with an invocation. The audience then sang Martin Luther's hymn, "A Mighty Fortress is Our God," after which the Scripture reading was given by Robert E. Jordan, 3d, President of the Class of 1958.

The baccalaureate address, entitled "Zest for Living," was given by Harold L. Hazen, '24, Dean of the Graduate School. The Review is pleased to present this highly significant message to the graduating class on page 471 of this issue.

The audience joined in singing Daniel Robert's "God of Our Fathers," after which prayer and benediction were offered by Dr. Stratton. The exercises were concluded with recessionals by John Stanley and George Frederick Handel rendered by Mr. Johnson.

Commencement

While families and friends of the graduating class gathered at Rockwell Cage for commencement exercises, the graduates, members of the Faculty, Class of 1908, the Corporation, and guests of honor met in the Armory for robing, last-minute instructions, and the customary making of newspaper photographs.

This year's graduating class, 1,112 graduates, was the largest ever to be graduated from the Institute, and the Rockwell Cage was filled to capacity. In fact, an overflow group of several hundred persons witnessed the commencement exercises from the Kresge Auditorium, where a closed-circuit television apparatus was called into play to image events taking place in the Cage a few hundred feet away.

As guests congregated in Rockwell Cage, David Johnson, organist, played background music and the processional march music. At 10:30 A.M. the academic procession began, headed by the officers and marshal of the Class of 1958, followed by the Faculty, the Class of 1908, members of the Corporation, and guests of honor. John J. Wilson, '29, President-elect of the Alumni Association as chief marshal, had the honor of carrying, for the second time in the Institute's history, the gold-plated silver mace made by Leverett H. Cutten, '07.

When all those taking part in the academic procession had taken their places, the national anthem was sung. Vannevar Bush, '16, Chairman of the M.I.T. Corporation, opened the exercises, and the invocation was given by the Very Reverend Monsignor Francis J. Lally, editor of *The Pilot*.

Acting President Julius A. Stratton, '23, introduced John J. McCloy, Chairman of the Board of the Chase Manhattan Bank, who gave the commencement address. In his introduction of Mr. McCloy, Dr. Stratton said, in part:

"Out of the tremendous range of his accomplishments, let me recall to you his invaluable service as Assistant Secretary of War in the dark and difficult days of World War II. Then, you will remember that, as president of the World Bank, he gave effective guidance to the first efforts of this country to assist underdeveloped areas of the globe. And subsequently that as U. S. High Commissioner for Germany from 1949 to 1952 his responsibilities were enormous, and in that critical period he played a major role in bringing West Germany back into the family of democratic states."

Mr. McCloy's response was the stimulating and scholarly commencement address to the Class of 1958 which The Review is happy to bring to its readers, beginning on page 475.

Dr. Stratton then presented the Goodwin Medal to Donald L. Kreider, an instructor in the Department

At the Alumni Day luncheon, the left-hand portion of the head table included as honored guests: Robert E. Jordan, 3d, '58; Mrs. Gilliland; Mrs. Skinner; Professor Edwin R. Gilliland, '33; Mrs. Jordan; Mrs. Roddy; David W. Skinner, '23; Mrs. Karl Taylor Compton; Gilbert M. Roddy, '31; Mrs. Stratton; Dr. Killian; and Saxton W. Fletcher, '18, toastmaster.

of Mathematics. This annual award, established in honor of Harry Manley Goodwin, '90, first Dean of the Graduate School, is awarded to a graduate student member of the academic staff for conspicuously effective teaching. The medal and cash award not only serve as an annual reminder of the Institute's wholehearted interest in effective teaching but also pay tribute to one of the Institute's most effective teachers of former years. Five other graduate students and 20 undergraduate students were also listed in the commencement program as receiving awards.

Presentation of degrees was made by Dr. Stratton who was assisted by Pietro Belluschi, Dean of the School of Architecture and Planning; C. Richard Soderberg, '20, Dean of the School of Engineering; John E. Burchard, '23, Dean of the School of Humanities and Social Studies; E. P. Brooks, '17, Dean of the School of Industrial Management; and George R. Harrison, Dean of the School of Science. Harold L. Hazen, '24, Dean of the Graduate School, and Robert M. Kimball, '33, Secretary of the Institute, were investors of hoods for those receiving their doctorate degrees.

Upon the conclusion of the presentation of degrees, Dr. Stratton gave the charge to the graduates. In this leave-taking address, traditionally delivered by the Institute's acting head, Dr. Stratton said, in part:

"We live admittedly in a highly materialistic age, and that materialism is enhanced by the very success of science over the physical world. Within the few years that you have been in college, this success has been reflected in an extraordinary demand for scientists and engineers. It would be only human had you been influenced in part in your attitude toward education, and even in the very choice of your careers, by the lure of high salaries and special employment opportunities.

"But education has a deeper meaning than the immediate pay-off. So it is that in the brief time that you have spent with us here at M.I.T. we have hoped to prepare you not simply for this June of your graduation but for those fruitful years ahead when you will have achieved the full maturity of your profession. No one at this moment can possibly foresee the technical demands that may be imposed upon you 10, 20, or 40 years hence. The most sophisticated techniques of 1958 will most likely be as outmoded in 1970 as the 1920 crystal wireless set is today. An education which comprises merely the accumulation of technical data and a skill in the manipulation of formulas offers no real professional or economic security whatsoever. Accordingly, the philosophy that has guided all our efforts on your behalf has been designed to cultivate in you truly professional attitudes, modes of thought that are both analytical and creative, and a capacity to deal in fundamentals that we believe will survive all the vicissitudes of change.

"In sum, it is our view that the only professional security of any account will rest in your power to keep pace with the advancing frontiers of knowledge. In awarding you these academic degrees today, we express our confidence that you now possess that power. You will, however, retain it only so long as you yourselves continue to cultivate assiduously your own fields of learning. If ever you are to achieve your full potentialities, then education must not cease with the college, but must be carried forward through the entire period of your active lives.

"There came to me this morning a telegram from the President of the United States. Let me read it to

Informal chats in Du Pont Court are enjoyed by members of the Class of 1933.

Beginning at speaker's desk, left to right, at the Alumni Day luncheon are: Saxton W. Fletcher; Mrs. J. R. Killian, Jr.; Dr. Stratton; Mrs. H. E. Lobdell; H. Leston Carter, '08; Mrs. S. W. Fletcher; H. E. Lobdell, '17; Mrs. Holt Ashley; Morris Cohen, '33, with camera; Mrs. Morris Cohen; and Holt Ashley, '48.

you. 'Please give my greetings to all attending the Commencement ceremonies of the Massachusetts Institute of Technology, and my congratulations to the graduates of the Class of 1958.

" 'Those students receiving degrees from the Institute this June face opportunities and responsibilities of a vast new order. In the expanding world of science, following the superb example of their President, Dr. James R. Killian, they can contribute much to the strength of their countrymen and to free men everywhere.

" 'Best wishes and Godspeed to each one. Dwight D. Eisenhower.' "

The academic recession of the assembly followed upon conclusion of Dr. Stratton's address, while Mr. Johnson played the organ postlude. For some, it was the final ceremony at the Institute. But many others took part in the Commencement Day luncheon which was held under canvas in the Great Court.

From Far and Near

Students from all over the world as well as the United States were awarded diplomas this June. Of the 48 states, only South Dakota and Delaware claimed no favorite sons among those receiving degrees on June 13. Massachusetts, of course, is home state to more graduates than any other: 258 Bay Staters collected degrees, 51 of them from Cambridge and 19 from Boston.

Among the graduates were 136 foreign students from 76 cities in 37 countries. All six continents were represented. Students hailed from such faraway places as Tel-Aviv, Israel; Bangkok, Thailand; Budapest, Hungary; Seoul, Korea; Pretoria, Union of South Africa; Sydney, Australia; Teheran, Iran; Bombay, India; and Buenos Aires, Argentina. Several places with strange sounding names had native sons honored at graduation. Among them: Pierrelaye and Vaucresson, France; Torreon, Coahuila, Mexico; Grantown-on-Spey, Scotland; Goa, Portuguese India; Barranquilla, Colombia; Pattani, Thailand; Kitchener, Ontario.

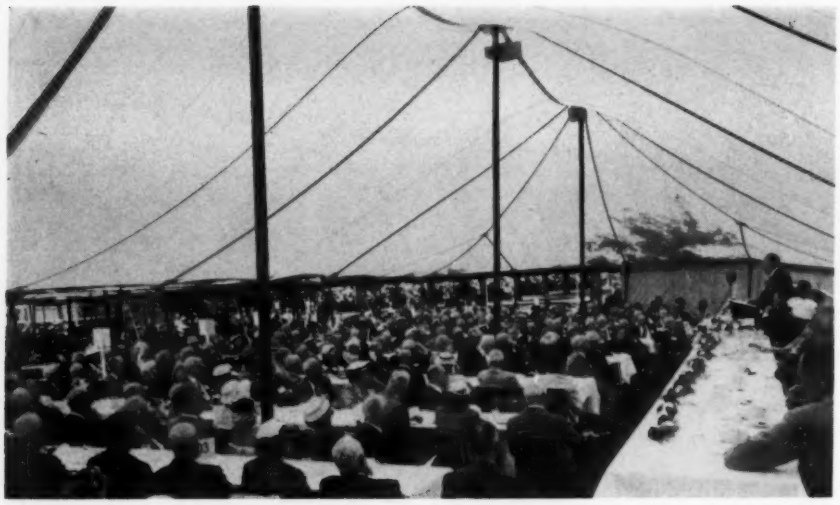
North from Mexico and South America to M.I.T. came 43 of the degree awardees; nearly two-thirds as many, 27, came south from Canada. Port Louis on the island of Mauritius is home to one S.B. recipient; Taipei, Taiwan, to a student receiving an S.M. degree. Granted to students from beyond our shores were 47 bachelor's degrees and 89 advanced degrees.

The commencement procession on June 13 included 1,112 candidates for a total of 1,191 degrees, plus about 70 people whose degrees were granted in September, 1957, or February, 1958, and who returned to the campus to collect them. By official count, M.I.T. awarded 693 bachelor's degrees, 370 master's degrees, 51 engineer's degrees, and 87 doctor's degrees at the 1958 commencement.

A few hard-working students received more than one bachelor's degree. Leading the list was William Dean Couper of Johnstown, Pa., who received an S.B. in Business and Engineering Administration at the same time he received an S.B. and an S.M. in Electrical Engineering.

The 115 people receiving Sc.D. and Ph.D. degrees (28 awarded as of September, 1957, or February, 1958) already hold among them a total of 202 degrees; 78 of these previous degrees are from M.I.T., and the other 124 are from 76 different colleges within and outside the country.

Several reuning Alumni and families of Alumni had a double reason for returning to M.I.T. for this year's commencement; the second, to see their son or daughter graduate from their alma mater. With the graduating offspring listed first and the parent afterward, they are: Edgar H. Bristol, 2d, S.B. VI, of Foxboro, Mass., and Benjamin H. Bristol'19, S.B. II; Miss Emilie Drew, S.M. XX, of Temple, N.H., and Thomas B. Drew'23, S.B. X and S.M. X-A; Lee B. Freese, S.B. I, of Fort Worth, Texas, and Simon W. Freese'21, S.B. IX-B; Carlyle L. Helber, Jr., S.B. III, of Forest Hills, N.Y., and Carlyle L. Helber'26, S.M. XIII-A; Alan C. Hurkamp, S.B. XV, of Hagerstown, Md., and Charles H. Hurkamp, Jr.,'27, S.B. II; Malcolm M. Jones, S.M. XIV, of Boston, Mass., and the late S. Murray Jones'21, S.B. and S.M. VI; William N. Latham, S.B. II, of Jamaica Plain, Mass., and Allen Latham, Jr.'30, S.B. II; Ralph E. Manchester, Jr., S.B. II, of Cambridge, Mass., and Ralph E. Manchester'29, S.B. II; Calvin J. Morse, S.B. II, of Peterborough, N.H., and Winslow C. Morse'22, S.B. XV; Miss Joanna M. Muckenhoupt, S.B. XVIII, of Newton, Mass., and Carl F. Muckenhoupt'29, S.B. VI, Ph.D. IX-C; Allen R. Philippe, S.B. I, of Alexandria,



From the head table at the Alumni Day luncheon, the Alumni gathered looked something like the view shown here. Several tents the size of that shown at left were required to protect some 1,400 Alumni and friends from sprightly June weather.

Va., and Robert R. Philippe'29, S.B. I; Charles C. Vicary, S.B. XV, of Erie, Pa., and James W. Vicary '33, S.B. XV; and Richard H. Wick, S.B. X, of Allentown, Pa., and the late Richard M. Wick'28, S.B. X, S.M. X-A.

To many persons who traditionally think of M.I.T. as a man's school, the coeducational character of its operations was emphasized as 19 young women received a total of 13 S.B. degrees, 2 S.M. degrees, and 4 other advanced degrees.

Commencement Luncheon

Graduates, with families and friends, had luncheon in the Courts adjacent to the main educational buildings.

Dr. Stratton spoke briefly to the graduates, and introduced those members of the Faculty who were retiring as of July 1.

H. Leston Carter, '08, representing the 50-year Class, reviewed changes that had taken place since his Class's "Boston Tech" days, and Russell E. Walstedt, '58, spoke of the Institute's humanities program and the value of such general education.

Finally, Dr. Killian admonished the graduates to "develop the subtle sense of the importance of running the race well" instead of aiming to win it.

Reunion of Class of 1933

As has been the custom in recent years, the 25-year Class held its reunion on the M.I.T. Campus where Baker House served as reunion headquarters and "home away from home." The Reunion Committee, under the chairmanship of Charles C. Bell, had worked hard to evolve an interesting program of events.

Registration of members of the Class of 1933 began Friday evening, June 13, and continued throughout all day Saturday, the 14th. No formal scheduled events occurred until the luncheon on Saturday, which was held in Walker Memorial. Leicester F. Hamilton, '14, Professor of Analytical Chemistry, who retired from the Institute this year, presided. At 2:30 the Class was photographed on the steps of Walker Memorial. Later in the afternoon, the informal program included sailing on the Charles River, swimming in the Alumni Pool, and tennis. Between 6:00 and 7:00 P.M. a social hour was held at the Faculty Club lounge.

The 25-year Reunion Banquet was held in the main dining room of the Faculty Club. President and Mrs. James R. Killian, Jr. ['26], Mrs. Karl T. Compton, and Professor and Mrs. B. Alden Thresher ['20] were special guests on this important occasion.

After breakfast on Sunday morning at Baker House, members of the Class of 1933 could attend either Catholic or Protestant church services at the M.I.T. Chapel.

A New England shore dinner was held at Castle Hill, Ipswich, where there was also opportunity to tour the Crane Estate. Busses left Cambridge at 11:00 A.M. and headed classmates back to Baker House from Ipswich by 4.30 P.M. A buffet supper and informal program was planned for the evening's activities at Baker House.

On Monday, the Class of 1933 joined hundreds of others in the general Alumni Day program.

Alumni Day — Registration

Alumni, 1,400 strong, registered in the lobby of the new Rogers Building or picked up their tickets for the day's events. All told, this was the largest Alumni Day on record, with an attendance of 1,400 at the Alumni Day luncheon, and 1,265 staying for the Alumni Day banquet and Pops Orchestra.

Education for a Changing World

The morning symposium was selected to deal with the topic of "Education for a Changing World." Gilbert M. Roddy, '31, President of the Alumni Association, presided at the symposium.

Morris Cohen, '33, Professor of Physical Metallurgy, spoke on "Soviet Education – A Lesson for America," which The Review is pleased to bring to its readers (page 483). In October, 1957, Dr. Cohen participated in a scientific mission to the Soviet Union and had opportunity to visit universities and

research institutes in Moscow, Leningrad, and Sverdlovsk (Siberia). He was in Moscow when the world's first satellite was launched. Dr. Cohen devoted particular attention to a study of the educational system of the Soviet system, and his Alumni Day symposium address is based, in large measure, on this first-hand experience.

Edwin R. Gilliland, '33, Professor of Chemical Engineering, brought the problem of education closer to home in his symposium address, "Research in Undergraduate Engineering Education." Dr. Gilliland is chairman of an M.I.T. Committee on Engineering Education, whose assignment is to study the future of the undergraduate program in engineering at the Institute. His Alumni Day address, reproduced on page 489, reviews several educational experiments which are being considered for use on a small scale.

Holt Ashley, '48, Associate Professor of Aeronautical Engineering, discussed "Astronautics – A Challenge in Engineering Education." Professor Ashley believes that a new kind of student is making his appearance in freshman classes at the Institute – a young man fascinated by problems of high-speed flight, space travel, and astronautics. The challenge of educating such a group of young persons is primarily one of using this intense interest as a springboard to provide the student with the broad fundamental background he needs for fullest achievement of his ambitions, while serving the vital future interests of the free world. Dr. Ashley's address, which appears on page 491, provides answers to some of these questions as they emerge in the Department of Aeronautical Engineering.

Alumni Day Luncheon

As graduates and their friends had done on the previous Friday, Alumni gathered under canvas in the Great Court for the largest Alumni Day luncheon on record. After all had served themselves, Saxton W. Fletcher, '18, turned the meeting over to Dr. Stratton for the customary annual report on the status of the Institute, the first to be delivered by Dr. Stratton as Acting President of the Institute. The full text of this address is given on page 482.

Coats or jackets were required attire on Alumni Day, for brisk winds made the day seem chilly despite sunshine.

Among the exhibits on display was a group of modern paintings in the Charles Hayden Memorial Library which, as the saying goes, "must be seen to be appreciated."

Upon conclusion of Dr. Stratton's address, Mr. Fletcher called upon Dr. Killian who, as Special Assistant to President Eisenhower for Science and Technology, spoke on the outlook for science and technology in America. He outlined the type of balanced program the nation should seek and the proper place which science and technology should be expected to play in the daily lives of the citizens of this country. Full text begins on page 479 of this issue.

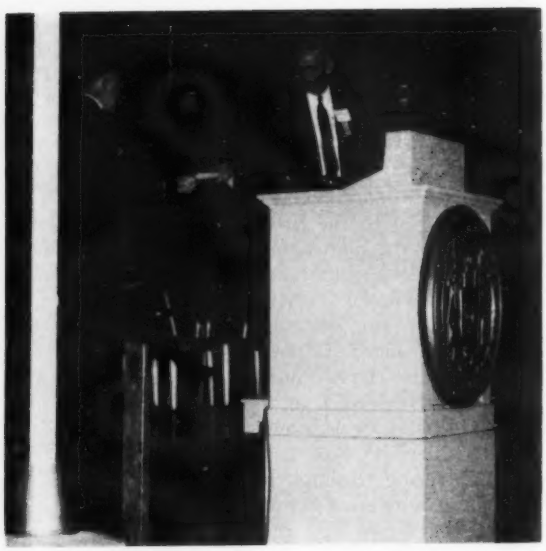
Demonstrations and Exhibits

Six major areas were open for inspection during the afternoon: the nuclear reactor, just nearing completion; the Computation Center, first on display a year ago; demonstration of inertial guidance; an exhibit on a new approach to the teaching of high school physics; a demonstration model of the M.I.T.-Harvard six-billion-electron-volt synchrotron now under construction; and an exhibit of postwar modern Italian painting.

Social Hour

Despite high wind – as may be judged from illustrations showing the way in which flags and banners stood out from their masts – nearly all who attended the Alumni Day banquet gathered on Briggs Field, between Kresge Auditorium and the Rockwell Cage, for an hour of sociability. Alumni and their wives could meet old acquaintances or make new ones, discuss the future of M.I.T., or reminisce about their student days.

H. E. Lobdell, '17, Executive Vice-president, escorts Miss Madeline R. McCormick from the stage of Rockwell Cage. Miss McCormick, Assistant Treasurer of the Alumni Association, and a member of its staff for nearly four decades, was made an honorary member of the Alumni Association on June 16. The principals and Chancellor Stratton seem pleased.



Acting President and Chancellor of M.I.T., J. A. Stratton, '23, receives check from the 25-year Class from Richard S. Morse, '33. A few minutes earlier, Harold S. Osborne, '08, had also presented a check to Dr. Stratton as gift of the 50-year Class. This ceremony has become a traditional event at M.I.T. Alumni banquets since the Alumni Fund was initiated in 1940.

Alumni Day Banquet

After the social hour, Alumni walked leisurely to nearby Rockwell Cage, where the Alumni Banquet got under way at 6:15 P.M. As is customary, seating was by classes, with the earlier classes nearer the stage. As usual, the 25-year Class had a large delegation on hand to wind up its reunion, which was held "on campus" as already noted. After a catered roast-beef dinner, provided by H. J. Seiler Company, a brief business session was held, at which Association President Gilbert M. Roddy, '31, presided.

Gilbert M. Roddy, '31, President of the Alumni Association for 1957-1958, receives gavel from President-elect, John J. Wilson, '29, whose presidential term began July 1, 1958. Dr. H. O. Osborne applauds the ceremony which, incidentally, concluded the Alumni Day banquet.

Mr. Roddy requested H. E. Lobdell, '17, to escort Miss Madeline R. McCormick to the stage to receive felicitations of all those present, as well as a certificate of honorary membership in the Alumni Association. In his tribute to Miss McCormick, who is assistant treasurer of the Alumni Association, Mr. Roddy said that "a young, auburn-haired lady" came to Tech to do the accounting for the Educational Endowment Fund 39 years ago. "Fortunately for us, [she] remained at the Institute to keep the finances of the Alumni Association steadily 'on the rails.'" As Mr. Roddy transferred the certificate of honorary membership, Mr. Lobdell presented Miss McCormick with a bouquet of 39 American Beauty roses – one for each year of service.

Mr. Roddy then called upon Harold S. Osborne, who presented the gift of the Class of 1908. Dr. Osborne announced that his Class had raised the sum of $170,923, a portion of which has been designated as a contribution to the Faculty Salary Fund. Counting this portion of the Class gift, matched in part by Alfred P. Sloan, Jr., '95, Dr. Osborne stated that the gift of the Class of 1908 could be reckoned as amounting to $195,838.

Richard S. Morse then presented the gift of the Class of 1933, recalling that since the Alumni Fund was organized in 1940, the Class had contributed $352,790.70. Mr. Morse also reported that he had a check for $85,867.88 as the gift of his Class on their 25th anniversary.

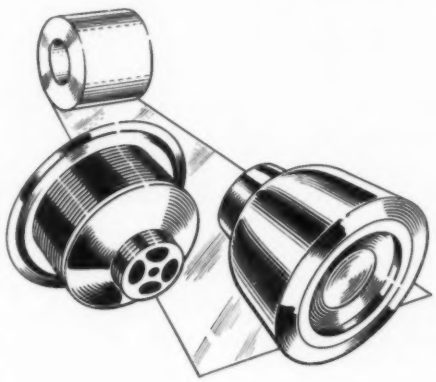
As his last presidential duty, Mr. Roddy reported that 13,102 Alumni had contributed to the Alumni Fund during his term of office and that the amount given to the Institute through Alumni amounted to

(Concluded on page 504)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Although miles apart in their functions the door knob and sink strainer shown below have one thing in common. Both are made from Revere Brass Strip. Revere Leaded Brass Strip was used to make the sink strainer because of its deep drawing characteristics (strainer had to be drawn from .065″ gauge x 7″ strip to a 2½″ depth), the ease with which large diameter threads are machined, the excellent surface it develops for chrome plating and, of course, the inherent corrosion resistance of brass.



The Revere Brass Strip used by the manufacturer of seamless, one-piece door knobs possessed still other characteristics that made it the most desirable for that specific purpose. Because of the unique procedure by which these knobs are made the brass has to be able to stand up under some mighty rugged going. Further, the brass strip has to be of uniform gauge and be without any sign of fracture or crimping when drawn, as well as have consistently correct grain structure to insure a smooth, flaw-free surface on the finished knobs without extensive finishing and polishing operations.

These are but two of the literally thousands of ways Revere Brass Strip makes it possible for manufacturers to offer *their* customers a superior product at the lowest possible cost.

The combination of unusual properties makes Revere Brass Strip, in various anneals and tempers, equally suited to stamping and spinning. Manufacturers have found that the high ductility and malleability of various Revere Brass Alloys effect savings in time and cost because deeper draws in one operation are possible. And, because of the low, work-hardening rate, a combination of forming processes is frequently possible in making intricate shapes without the need for intermediate annealing. Should annealing be required the temperatures used are low (usually not over 1100° F.) which means lower fuel cost.

Revere Brass Strip not only permits deep draws, but fast draw speeds as well, which is particularly desirable for repetition press work or other operations where parts are produced in large quantities. This means relatively low power consumption.

Revere Brass Strip does not foul dies quickly, requiring only a minimum of die re-dressing. And one of its most desirable features is that it plates well and polishes easily, requiring only a minimum of finishing.

Revere Brass Strip in its various alloys is still another example of how, by fitting the metal to the job, it is possible to produce superior products at the lowest possible cost.

Practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the *right* materials.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N. Y.

HEVI DUTY

IN STEP
with tomorrow's
stepped-up
DEMANDS

INDUSTRIAL HEAT-TREATING FURNACES

CONVEYOR FURNACE — Brazing and bright annealing are performed in this hydrogen atmosphere furnace.

SALT BATH FURNACE — Immersed electrodes provide rapid and uniform heat for several heat-treating processes requiring temperatures from 300° F. to 2300° F.

VERTICAL RETORT FURNACE — A removable sealed retort makes this furnace ideal for carburizing, nitriding, and many other heat-treating processes.

HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Harold E. Koch, '22, *President*
Elton E. Staples, '26, *Vice President*
Chester Meyer, '36, *Assistant Secretary*

REUNION IN CAMBRIDGE

(*Concluded from page 502*)

two and a quarter million dollars. Finally, Mr. Roddy called upon John J. Wilson, '29, to come to the rostrum and assume his duties as president of the Alumni Association for the year beginning July 1, 1958.

Mr. Wilson took office from Mr. Roddy and presented a handsome gavel to Mr. Roddy to mark the completion of his term of office. The gavel was used in declaring the meeting adjourned, and those present marched across Briggs Field for the Pops Orchestra Concert to be held in Kresge Auditorium.

Pops Orchestra Concert

With every seat in the Kresge Auditorium taken, promptly at 8:30 P.M. the Boston Pops Orchestra – with Arthur Fiedler conducting – began its second Alumni Day concert to be held on campus. The program, marking the 47th program of the current season, was in three parts. The first portion included: "Rakóczy March" by Berlioz; "Suite from 'Cakewalk'" by Kay; "March of the Little Lead Soldiers" as an encore; "Im Krapfenwald'l, Polka" by Strauss; "Hoe Down Rodeo" as the second encore; and "Suite from 'Gaite Parisienne'" by Offenbach.

After intermission Maro Ajemian joined the orchestra in Khachaturian's "Concerto for Piano and Orchestra." Miss Ajemian gave a brilliant and flawless performance, as did the orchestra, although the concerto was probably a bit too modern for the audience.

The final portion of the program included excerpts from various dances arranged by Hayman and entitled "Dancing Through the Years," after which the popular "Colonel Bogey March" was presented as the third encore. Following "Serenata" by Anderson, the orchestra played "Gypsy Tango – Jealousy" as its fourth encore, and followed this with "76 Trombones, from 'The Music Man'" by Willson. For the concluding selection, Arthur Fiedler and his musicians rendered the "Stein Song," as members of the audience rose to their feet to "Give a rouse, then, in the May-time." Thus was the day brought to a successful conclusion.

Finis

As the audience left Kresge Auditorium, the floodlighted Rogers Building greeted them across the mall. Many searched out their cars from the nearby parking lots and returned to their hotels or began the long trek back to their homes in cities across the nation. For those who did not drive, busses were waiting to take passengers toward Harvard Square or, in the opposite direction, to Massachusetts Station in Boston. Tech Alumni are probably an affluent lot, for there were few who patronized the Massachusetts Transit Authority orange and yellow vehicles. Perhaps they were dissuaded by the hawking taxicab drivers who were able to park fairly close to the Auditorium.

Thus did the reuning Alumni melt into the night, firm in their conviction to return again soon.

Venus, in blue light, 200-inch Palomar telescope

SPACE FLIGHT and NUCLEAR PROPULSION

A drastic reduction in vehicle mass ratios... substantially increased specific impulse values... a capability for achieving very high speeds... these are some of the significant advantages that will come from the application of nuclear energy to space flight.

A number of different propulsion systems have been proposed to utilize nuclear reactions. The simplest system consists of a fission reactor through which the propellant is passed, heated, and then expanded through a rocket nozzle. Fission reactors can also be employed as a source of energy to generate electric power, which in turn can be used to accelerate ions or charged particles, or to create and accelerate a plasma. And fusion reactors, when developed, can be used to generate electric power for the same purposes. In addition, in the case of the fusion reactor, there is the attractive possibility that the reaction energy can be used directly without conversion to electric power.

The fission-powered thermal propulsion system will probably constitute one of the next major advances in space technology. As an example of the gain which can be achieved, consider a vehicle with a payload weight of about 25 tons for a manned flight to one of the nearer planets, landing, and returning. Powered by chemical rocket engines, the takeoff weight for such a vehicle would be 50,000 tons. But powered by a fission-thermal propulsion system, weight at launch would not exceed 500 tons... a 100-fold reduction in the mass ratio. Considerably greater gains are predicted for the more advanced systems.

Systems studies and advanced research in the application of nuclear energy to the requirements of space flight are in progress at Space Technology Laboratories. This work illustrates the emphasis at STL on the exploration and development of new concepts and techniques in ballistic missile and space technology.

Both in support of its over-all systems engineering responsibility for the Air Force Ballistic Missile Program, and in anticipation of future system requirements, STL is engaged in a wide variety of analytical and experimental research. Projects are in progress in electronics, aerodynamics, hypersonics, propulsion and structures.

The scope of activity at Space Technology Laboratories requires a staff of unusual technical breadth and competence. Inquiries regarding professional opportunities on the STL Technical Staff are invited.

SPACE TECHNOLOGY LABORATORIES

A Division of The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

If time is an element in the operation of your product or process, be sure to call in your factory-trained HAYDON* Sales Engineer. HAYDON Timing Motors utilize time, control time, master time . . . precisely, quietly . . . bettering performance and opening new horizons to product and process use.

Put time to work now by writing for the name of your HAYDON timing specialist, and for the catalog, "Electric Timing Motors, Timing Devices and Clock Movements."

*Trademark Reg. U. S. Patent Office

Haydon AT TORRINGTON
Division of General Time Corporation
Timing Motors and Devices

DEPT. TR, ELM ST., TORRINGTON, CONN.

☐ Send me the name of my HAYDON Sales Engineer.
☐ Send me the HAYDON catalog.

NAME _____
POSITION _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE ____ STATE ____

ZEST FOR LIVING

(*Continued from page 474*)

derstand even superficially, what goes on in a drop of water from a stream or pond, has opened before him a vast new world. Then, inviting exploration at our very doorstep are the wealth of flora and fauna, with all their variety and beauty, their complex life histories and their fascinating interrelations. An exciting personal adventure awaits him who explores these great manifestations of nature and who thus qualifies himself to experience vicariously with the biologist, his thrill at each new discovery.

In another great realm, that of human affairs, let us glance at history. This field is so immense and rich that the professional historian himself may aspire to expertness only in a particular phase, or in a limited period and area. Yet each of us may reasonably aspire to an awareness of the sweep and patterns of known history, including the often-ignored East, as well as the West. As mentioned earlier, such an awareness of the major epochs and movements in history helps us to place in perspective the day's news as it comes to us from all parts of the globe, and from cultural and historical settings remote from our own. We also become prepared to share the thrill of the archeologist's discovery as he enlightens us about great past civilizations.

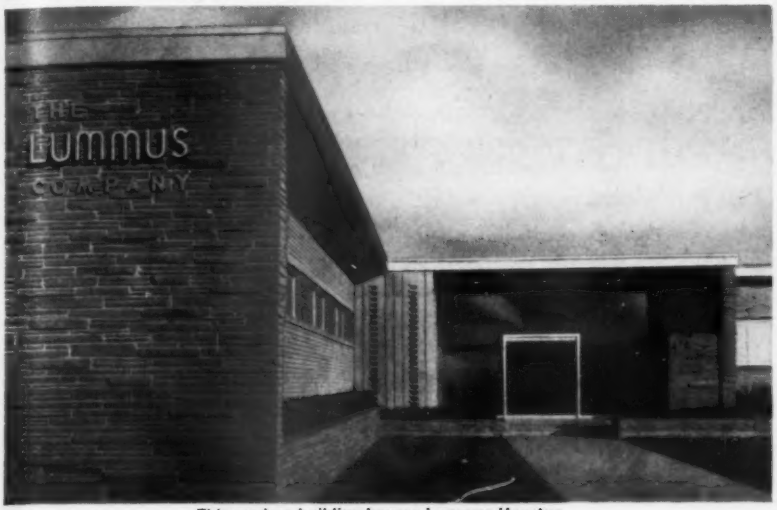
Then there is the appeal of the fuller understanding of a particular place or period in history that complements and illuminates the broad sweep. I hope that those of you who were exposed to our first-year Humanities' program discovered something of the satisfaction derived in developing such a fuller understanding. I hope also that you will frequently subject yourself, and succumb to, the temptation to read, and read widely, among the wealth of fascinating materials old and new that tell us of the story of man.

If one has or makes opportunity to travel, and I urge that you do make opportunity whenever you can, such background reading enriches immeasurably one's ability to see and perceive. Travel itself can be an extremely educational and stimulating experience. Yet I have seen too many people "on tour" utterly unaware and bored among some of the most fascinating opportunities. Travel can disclose utterly different sets of values and cultural patterns that sometimes necessitate radical revision of one's concept of his own country and countrymen. But whether attained by actual travel or by reading in one's own living room, understanding more of the great story of mankind can add greatly to zest for living.

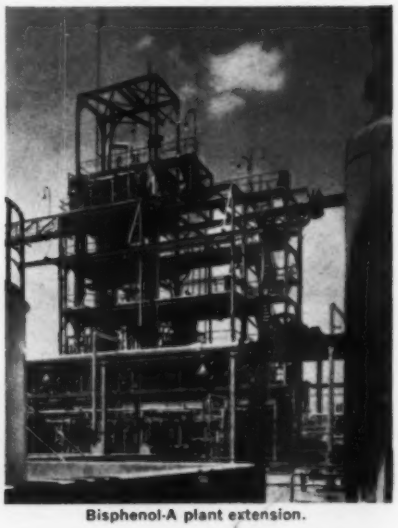
Then there is the vast field of human feeling, ideals, aspirations, interpretation of life, that has led to almost infinite riches in the fine arts. It borders upon sacrilege to mention these so summarily, but within the realms of literature, painting, sculpture, music, architecture, are rich expressions of the human spirit beyond number. These are freely open to all who will but study and seek to understand. Through them one may share some of the deepest experiences of men.

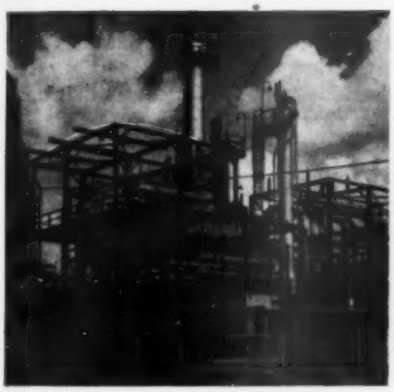
(*Concluded on page 508*)

ONE OF A SERIES OF ADVERTISEMENTS ON LUMMUS' WORLD-WIDE FACILITIES

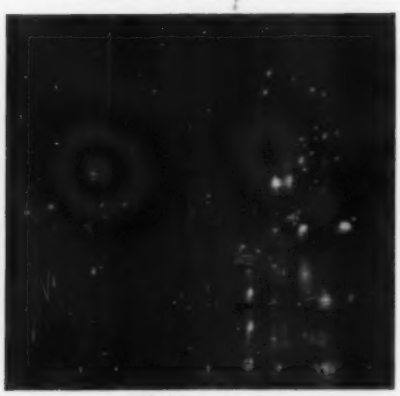


This modern building houses Lummus Houston.


Bisphenol-A plant extension.


First ultraforming unit in the U. S.

$11 million ethylene oxide plant.


Complete refinery.

Lummus Houston serves the Southwest's process industries

Staffed by over 300 specialists—this office is completely integrated for design, engineering and construction for the constantly expanding Southwest

The Lummus Houston office, like all Lummus engineering offices and subsidiaries throughout the world, can design, engineer, procure and construct any size or type plant for the process industries.

Lummus Houston, established in 1939, has to its credit scores of the more than 700 Lummus petroleum, petrochemical, and chemical projects completed throughout the world in the last half century.

Recent Lummus Houston projects, pictured above, include the first Ultraforming Unit in the United States, a Bisphenol-A plant extension with additional facilities for the manufacture of EPON Resins, an $11 million Ethylene Oxide Plant, and a complete refinery which has operated as one of the most profitable in the United States.

The highly trained staff is always ready to join forces with her six sister Lummus offices and subsidiaries—located in New York, Montreal, Maracaibo, London, Paris, The Hague—to make Lummus facilities easily available everywhere.

See Lummus on your next project.

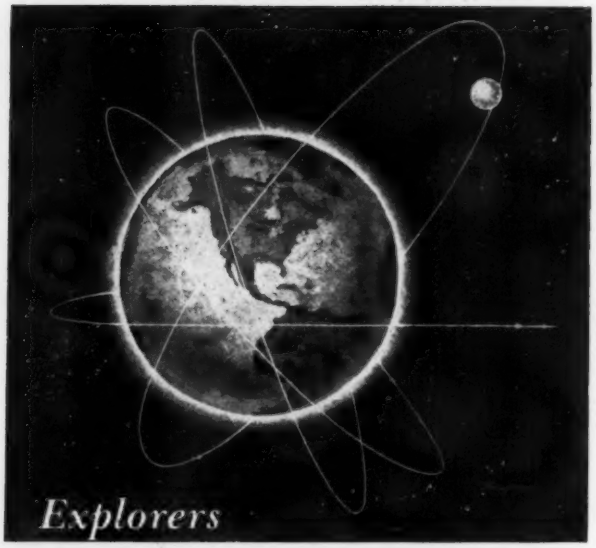
* * *

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y., Houston, Chicago, Washington, D. C., Montreal, London, Paris, The Hague, Caracas, Maracaibo. *Engineering Development Center*, Newark, N. J.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 MADISON AVENUE, NEW YORK 17, N.Y.



into the space age

MIT. GRADUATES AT ALLIED RESEARCH ASSOCIATES, INC.

Name	Degree & Course	Year	Position
Oiva R. Anderson	SB, XVI SM, XVI	1947 1948	Senior Engineer
Martin Annis	SB, VI PhD, VIII	1944 1951	Chief Project Scientist
Robert P. Bartlett	SB, VI	1955	Research Engineer
Wallace P. Boquist	SB, IX-A	1954	Research Physicist
Roland J. Boucher	SM, XVI	1939	Staff Meteorologist
Claude W. Brenner	SB, XVI SM, XVI	1947 1948	Chief Project Engineer
William B. Bryant	SB, XVI ScD	1943 1955	Senior Engineer
Jack W. Carpenter	SB, SM, VI-A PhD, VIII	1951 1957	Senior Physicist
Arthur B. Cicero	SB, II SM, II	1953 1954	Senior Engineer
Carolus M. Cobb	SB, V PhD, V	1944 1951	Senior Chemist
Daniel J. Fink	SB, XVI SM, XVI	1948 1949	Chief Engineer
Gilbert Fryklund	SB, XVI	1957	Research Engineer
Arnold H. Glaser	ScD, XIX	1952	Chief Project Scientist
Lawrence E. Golden	SB, XVI-A SM, XVI	1952 1953	Staff Engineer
William D. Green, Jr.	SB, II SM	1943 1949	Chief Project Engineer
David C. Knodel	SB, XVI SM, XVI	1947 1951	Senior Engineer
Lawrence Levy	SM, XVI	1948	President
Philip Marshall	SM, II	1955	Staff Engineer
James J. McInnis	VI	1959	Research Engineer
Roger W. Milligan	SB, XVI	1950	Staff Engineer
Arthur C. S. Roberts	SB, XVI	1947	Senior Engineer
Leopold J. Rossbach	SB, SM, VI-A	1950	Senior Engineer
John N. Rossettos	SB, XVI SM, XVI	1955 1956	Research Engineer
Melvin R. Rubin	SM, I	1951	Staff Engineer
Richard Rubino	SB, XIV	1952	Personnel Manager
Frank Scherb	SB, VIII PhD, VIII	1953 1958	Staff Physicist
Charles M. Shure	SB, XVI	1957	Research Engineer
Calvin Y. Sing	SM, XVI	1954	Staff Engineer
Robert B. Smith	SB, IX-A SM, XIX	1944 1951	Research Meteorologist
Thomas B. Smith	SB, VI	1955	Staff Engineer
John Stewart	SB, XVI	1953	Staff Engineer
Robert A. Summers	SM, XVI ScD, XVI	1946 1954	Chief Project Engineer
Raymond Wexler	SM, XVI	1939	Senior Meteorologist
Ann C. Wilfert	SB, VIII	1953	Research Physicist

ZEST FOR LIVING

(*Concluded from page 506*)

But apart from and in addition to such creative works of men, individual people themselves offer a boundless source of new insights and interest in life. How seldom do we develop the full potential of opportunities for exchange of thoughts and experiences in our day-by-day associations with others who have seen, thought, studied, worked, and lived in realms different from our own. The rewards of serious conversation, or of merely friendly talk on interesting ideas, will always be cherished by the inquiring mind.

I am barely suggesting tremendous areas for opening up new interests and for cultivating verve of mind and spirit. Obviously one individual can explore only a small fraction of these areas. Yet each of us can, if he will, continually grow in catholic awareness, in sense of proportion and perspective, in his scale of values, thereby immeasurably enhancing his life and experience. And despite the seeming hurry, pressure, and urgency of daily duties, let us occasionally withhold from other commitments and guard as great treasure the time and energy for thought and reflection on all these matters that contribute so much to our zest for living.

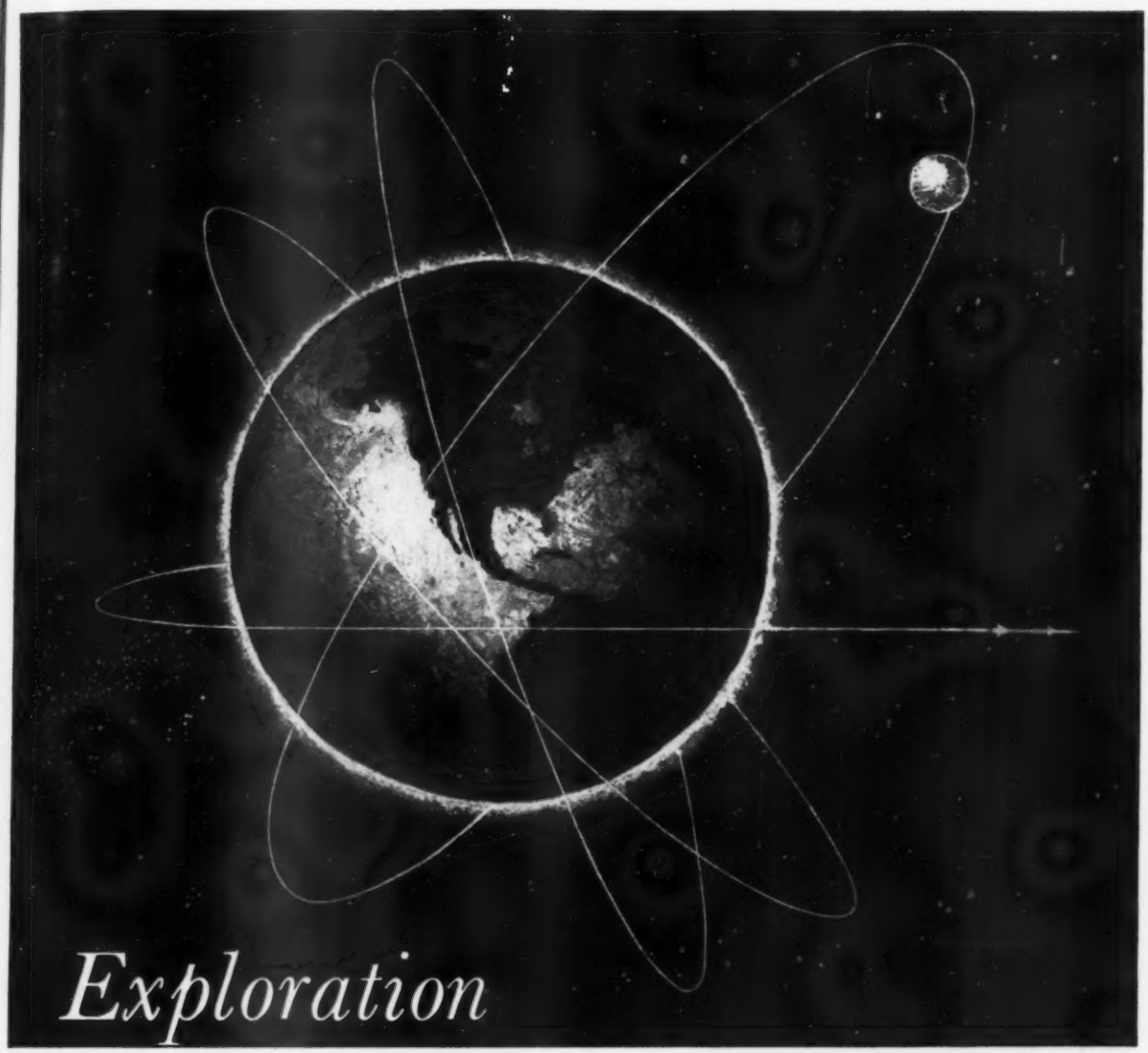
The thoughts I would leave with you are these. Life lived actively rather than passively seems good. Instinctively we feel that zest for living is good. This spirit comes partly from vigor, competence, courage, and productivity in our professional life, but partly and importantly from an enthusiasm for awareness and understanding, sympathetically and actively developed among all of the great areas of human endeavor. To him who has genuine curiosity and interest in the people and the world about him, life can never be dull. It will be full, full of the zest for living.

SOVIET EDUCATION

(*Concluded from page 488*)

us more satisfaction. The possible consequences are so far reaching that, like national security, we can no longer rely upon each local community to recognize, let alone meet, its share of the challenge. Federal resources must be directed into this all-embracing form of capital investment. Of course, any massive preparation for the future, even like the construction of vast underground shelters and the dispersal of cities, is bound to be fraught with waste and inefficiencies. However, there is a high probability that, considering the long-term aspirations of mankind on this globe, "putting our money on education" will have turned out to be the most rewarding insurance that we could possibly buy in our generation.

We are fortunate, indeed, to enjoy such a commanding head start over the Soviet Union in wealth, experience, productivity, standards of living, and freedom of inquiry. If we will respond to the lesson before us — to cultivate the brain power of our people by starting seriously with the education of our youth — we need not fear our rendezvous with destiny.



Exploration

into the space age

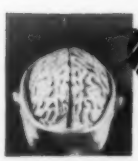
Brainpower when you need it . . . focused squarely on space age problems . . . this is what Allied Research Associates, Inc. offers you.

The broad capabilities to be found here — drawn from a dozen and more engineering and scientific disciplines, and teamed in combinations custom-assembled for the particular problem — can be put to work for you in a single engineering study . . . a complete analytical and experimental program extending from research through prototype fabrication . . . or advanced investigations in new fields of technology.

RESEARCH, ENGINEERING, DEVELOPMENT *for problems of the space age . . .*
including **Satellite Research** — *instrumentation, control, recovery*
Missile Performance and Design Criteria — Space Phenomena

high temperature physics • physical chemistry • physical meteorology • materials and material properties • electronics and instrumentation • systems engineering • atomic weapons effects • theoretical and applied aerodynamics and hydrodynamics • applied mechanics and thermo-elasticity • aeroelasticity and structural dynamics • vibrations analysis and testing • custom vibration isolation • aircraft operations • human factors • specialized mechanical design

BRAINPOWER . . . *when you need it*



Allied Research

ALLIED RESEARCH ASSOCIATES, INC.
43 Leon Street, Boston, Massachusetts — GArrison 7-2434
A subsidiary of VERTOL AIRCRAFT CORPORATION

Challenging positions open for engineers and scientists

NEW ENGLAND TRANSFORMER CO. INC.

47 McGrath Highway,

Somerville, Mass.

Manufacturers of Electronic Transformers

Leon W. Freeman, *Treasurer*

Sampson Grunes, *Chief Engineer*

Class of 1942

RICHARDS PYROMETER SUPPLIES

Control Temperatures More Closely
Reduce Cost and Save Time

Our Catalog shows you how!
Get your free copy today!

★ THERMOCOUPLES
★ PROTECTION TUBES
★ THERMOCOUPLE WIRE
★ LEAD WIRE
★ INSULATORS
★ TERMINAL HEADS

Low prices for top quality
Prompt shipment from stock

Arklay S. Richards '19 Whitman A. Richards '53

ARKLAY S. RICHARDS CO., INC.
Manufacturers of Pyrometer Supplies Since 1938
4 Winchester Street
NEWTON HIGHLANDS 61, MASS.

MAINTAINING THE STRENGTH OF U.S. TECHNOLOGY

(*Continued from page 481*)

have a far greater chance of producing great scientists in the United States if we have a more widespread understanding of science.

With its growing complexity and responsibility and external challenge, American society today presses hard on the total creative and intellectual resources of its people. This means that we must find and develop the highest possible percentage of our native high talent; it also means that we must encourage each individual to achieve to the very highest degree the special excellence that he possesses.

We must also be concerned with the attitudes, values, and motivations which have given vigor to our technology and which are important to its continuing strength.

So far our society has demonstrated a sustained eagerness to find better ways of doing things. We have forged ahead because we wanted things to change. The revolution of modern man – the revolution which has found its fullest expression here in the United States – lies essentially in this: it is a revolt against things as they are when there are ways of doing things better. It is a revolution based upon determination rather than determinism, upon constructive discontent rather than disruptive discontent. It is a revolution against all the forces which hinder man in building a better life. Science has had a major part to play in shaping this basic American faith in creative change and improvement.

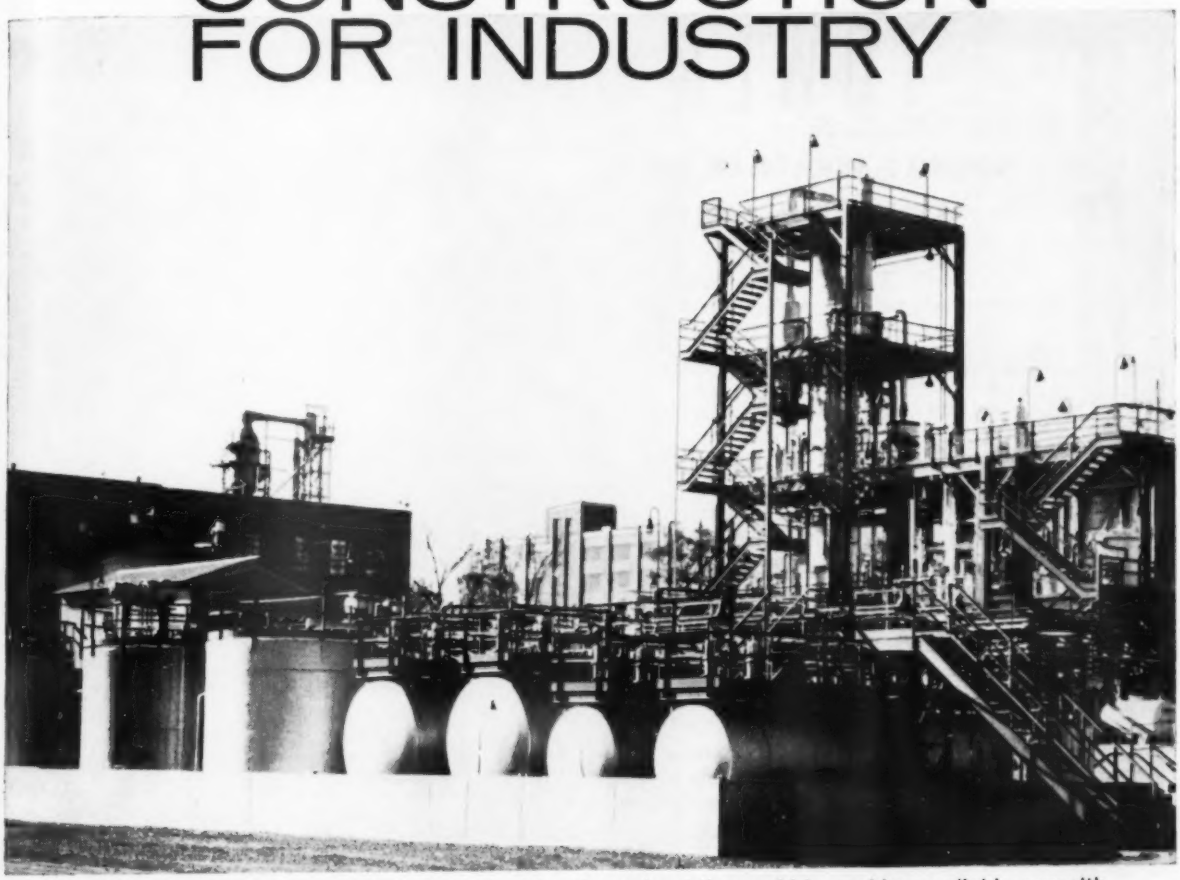
The course of our nation has been deeply affected by the tenet, very early embraced, that nature could be put to work for the benefit of man and that it is possible to wrest from nature a range of benefits to meet the needs of our people – that science and technology provide a means to advance the welfare of our people and that this has been a better way to progress than through radical social change or ideological nostrums.

I do not suggest that we have any warranty, expressed or implied, that progress is inevitable or immutable; I only describe the deep-rooted American belief that progress is an achievable and worthy goal. I reflect my own intuitive belief that man has the capacity greatly to improve himself and his society, and that pessimism and *status quo*itis are deficiency diseases of the human spirit.

Today we hear voices of doubt and pessimism, decrying or questioning the concept of progress. The increased currency of such phrases as the "illusion of progress" and the "corrosive effect of materialism" reflect an array of attitudes challenging the power of reason and the actuality of progress. Technology and science are attacked as contributing only to the convenience and comfort of life and not to its quality. In mentioning this attitude of doubt and pessimism, it is not my purpose to debate the theological or philosophical considerations on which they rest. My purpose is to express my contrasting faith that we can continue to draw the blueprints of a still nobler society, materially and spiritually, and that we can

(*Concluded on page 512*)

ENGINEERING AND CONSTRUCTION FOR INDUSTRY



Vulcan-Cincinnati, Inc. serves major industries throughout the world by making available a wealth of engineering and construction talent with an outstanding record of achievement in these areas:

process evaluation
pilot plant studies
plant layout
structural design
electrical design
piping drawings
project management
plant construction
pipe fabrication

M. I. T. Men At Vulcan:

J. J. HOGAN
L. W. NISBET
D. H. PARK
R. N. SUMMERVILLE
T. O. WENTWORTH

VULCAN-Cincinnati, Inc.

ENGINEERS and CONSTRUCTORS
120 SYCAMORE STREET • CINCINNATI 2, OHIO

Safe internal ladder extends full length of tower

310 FOOT TOWER

BRINGS WEATHER DATA DOWN TO EARTH

Sturdy Trylon Towers such as this help micrometeorology play an increasingly important role in air pollution control for modern industry.

This typical installation—for New York University's College of Engineering—aided the design and adjustment of smoke stacks for Consolidated Edison's new atomic- and oil-powered generating station. The rigidly-braced tower supports seven resistance thermometers and three Bendix-Friez Aerovanes on retractible arms. Special platforms at each location allow safe inspection of all equipment. Also included is a smoke generator which can be raised to various heights for comprehensive air current studies. The tower and accessories are hot-dip galvanized for maximum corrosion resistance.

As specialists in out-of-the-ordinary towers for over 20 years, Trylon welcomes the opportunity to quote on your next tower requirement—on the design, fabrication, installation or supervision of the entire system or of any component.

TRYLON® TOWERS

Trylon Towers are made only by:

THE WIND TURBINE COMPANY, West Chester, Pa.

ROBERT W. WEEKS '13, PETER G. PARK '40

In Canada: The Wind Turbine Company of Canada, Ltd., Toronto 9, Ontario

MAINTAINING THE STRENGTH OF U.S. TECHNOLOGY

(Concluded from page 510)

direct our advancing science and technology toward the realization of those plans.

If research is to continue to flourish and to give vigor and growth to our economy, these traditional American beliefs in the validity of progress and creative growth become increasingly important. They are the wellsprings of that zest and audacity which characterized our research and economy in the past and, God willing, will characterize them in the future.

With these examples of some of the opportunities and problems facing us, let me emphasize the great responsibility which rests upon science today in the light of the extraordinary opportunities which it has been given to participate in the formulation of national policy. The growing linkage of science and technology with government demands of science a new order of poise, steadiness, and statesmanship. The current emphasis on science, if it is not to cause reactions adverse to science, also requires of the scientific community restraint, humility, and a sense of proportion. It requires of scientists a recognition that science is but one of the great disciplines vital to our society and worthy of first-rate minds, a recognition that science is a partner – sharing and shouldering equally the responsibilities which vest in the great array of professions which provide the intellectual and cultural strength of our society.

These needs and objectives for furthering our national technological effort are drawn from the Agenda of the President's Science Advisory Committee. It is, of course, concerned with many additional things, including many classified aspects of our military technology, the better distribution of scientific information in the United States, and the furtherance of cooperative scientific activities throughout the free world. Pursuing all of these objectives, the committee is impressed by the urgent importance of enlisting more first-rate people from the scientific, engineering, and industrial community to help in solving these great national problems. We will not make adequate headway in solving them without participation of many men of imagination and vigor in public service. One of the heartening things to me about my experience in Washington has been the extraordinary response which we have already found among the scientists of the country in coming to Washington to help. Not a single scientist who has been asked to participate has failed to respond, but there must be many more if we are to achieve qualitative goals in our national policy-making and our national efforts in the field of science. And so I say "Be ye doers of the word, and not hearers only."

In setting forth these special requirements and opportunities for an advancing science and technology, I am also expressing my faith in the growing opportunity of science, not only to deepen our understanding and enlarge our views of the world, not only to enhance our sense of beauty and order, not only to augment our power and wealth, but also to minister humanely, benignly, and responsively to the needs of our fellows, our government, and our country.

toward

to give
ditional
nd crea-
They are
ch char-
ast and,
ture.
rtunities
he great
y in the
h it has
n of na-
nce and
ience a
nanship.
o cause
of the
a sense
ognition
es vital
a recog-
l shoul-
t in the
intellec-

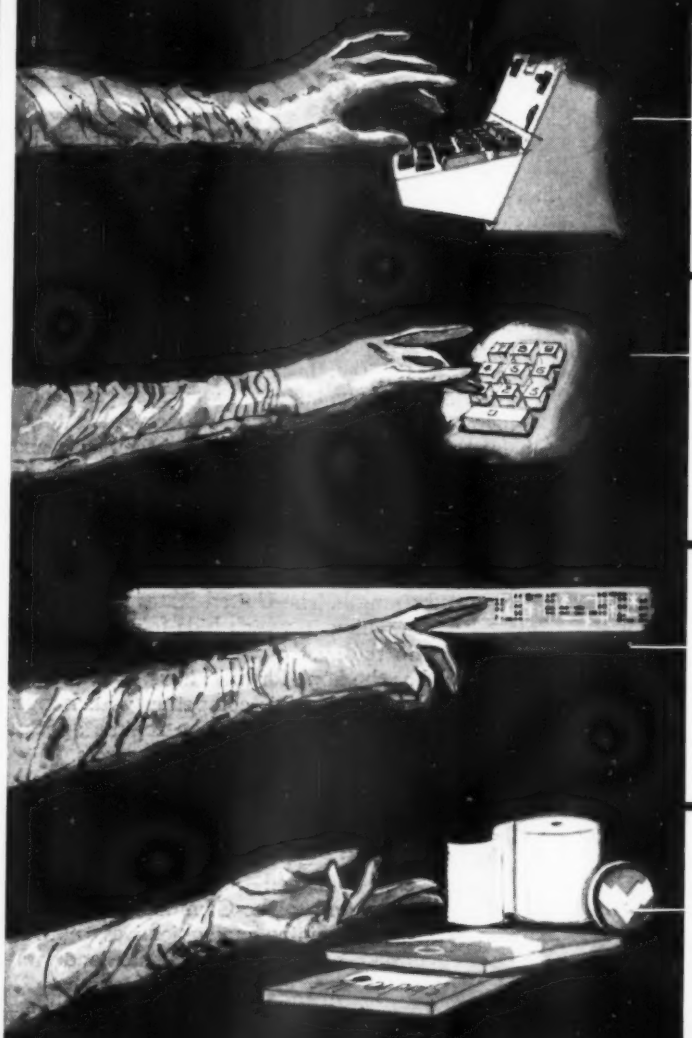
our na-
Agenda
ee. It is,
things,
ry tech-
nforma-
e of co-
he free
mmittee
enlisting
neering,
g these
dequate
ation of
service.
experi-
nary re-
ong the
gton to
sked to
nust be
goals in
efforts
doers of

nts and
d tech-
growing
r under-
not only
only to
minister
needs of

REVIEW

underwood

MASTERS YOUR PAPERWORK



Golden-Touch®

TYPING

Electric • Standard
Portable

Master-Touch®

ADDING & ACCOUNTING

Adding-Subtracting
Portable Adding-Subtracting
Calculating • Posting & Balancing
General Accounting

Master-Control®

DATA PROCESSING

Data-Flo Systems
The Electronic Business Computer

Print-Master

SUPPLIES

Serving all modern
business machines.

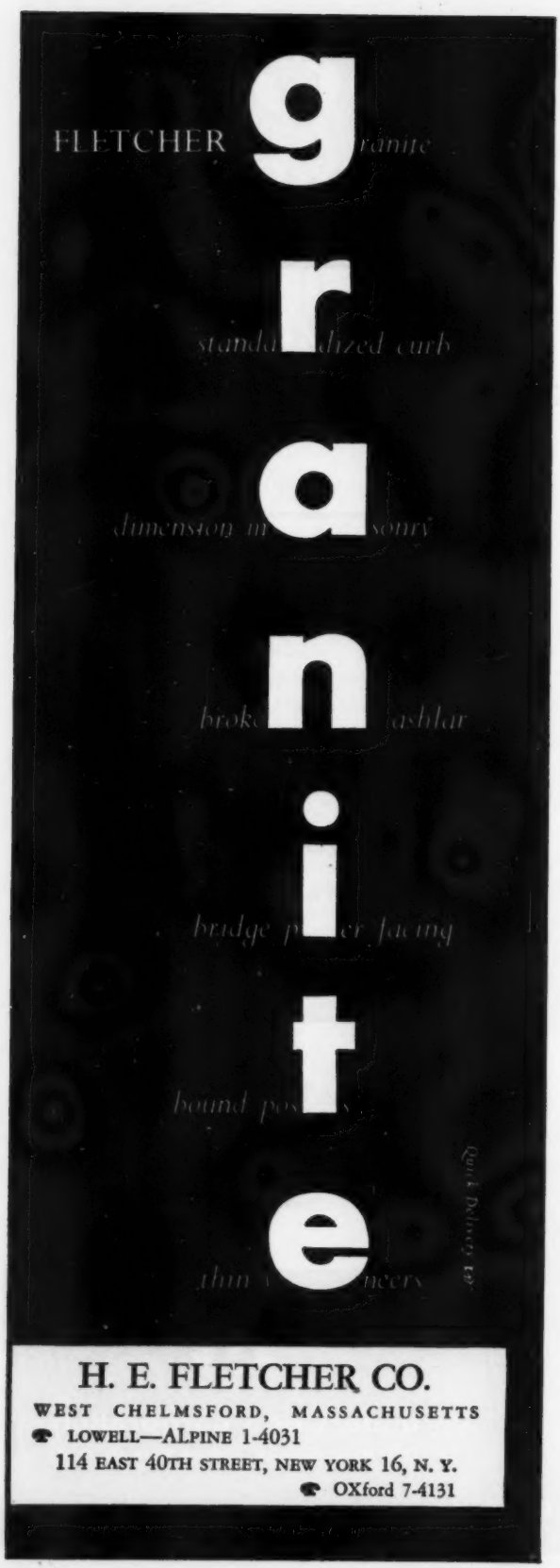
Many paperwork problems can be solved more economically by Underwood than by any other office machine company. Why not discuss your paperwork problems with an Underwood sales representative?

UNDERWOOD MARKETS ITS PRODUCTS IN 115 COUNTRIES

underwood

underwood corporation

One Park Avenue • New York 16, N.Y.



OBLIGATIONS OF THE SCIENTIST

(*Continued from page 478*)

have to be foregone, but it might be that, in the end, a more satisfying, knowledgeable, and worth-while destiny would ensue.

To speak of what we need to do is not to detract from what we have nobly done. As history goes, we need apologize to no one for the contributions we have made to the world's progress. We created new and broadening political institutions and have made them work. We were the originators of the greatest revolution in terms of freedom of thought and action that the world has ever experienced. Though we, as de Tocqueville said, did develop in the shade, when finally we blossomed we gave mankind a concept of liberty that, in spite of all the attacks upon it, has by no means run its course. We intervened decisively in two world wars to quell aggression against our friends and against freedom itself, and we have contributed a larger amount of our wealth to the succor, rehabilitation, and development of mankind than has any other nation since the dawn of history.

In view of the record and the relatively short period of our involvement, I do rather rebel at the suggestion that either in respect of this hemisphere or elsewhere we have taken the world for granted.

It is necessary, however, that we look straight into the face of our challenges, appraise their size and weight, and act resolutely. It will not do merely to meditate on our meritorious past or to assume that somehow victory will crown our shield. Whether as individual or as nation, destiny has a way of sooner or later presenting us with a competitor worthy of our size and strength. The United States now has the Soviet Empire facing it, which bids fair to supplant this country in the eyes of the undeveloped people of the world as the hope for the future. It is in these countries, where freedom is competing with hunger for a decent life, that a totalitarian regime appears attractive as a short cut to economic progress.

I think we have to admit that we have recently been caught off-balance. The Russian scientific advances certainly did just this. It now appears that we shall have to face a real and ominous economic offensive. We have passed the time when we can afford only to respond to the Communist initiatives. We must now re-examine our objectives, both at home and abroad, and lay out a definite and well-enunciated program of achievement of our own. It involves much more than government action — though government must give a certain leadership. Our educational system must be greatly improved — our youth must be reinspired to the need for their participation in the achievement of the objectives; the scientist and technician must emerge from their laboratories and offices, and the businessman must seek his interests in a larger perspective than has heretofore been his instinct.

I feel that thus far I have ignored some of my own precepts. I have spoken to you as if you were all citizens of the United States faced with the problems of the United States. I have not followed the global approach.

(*Concluded on page 516*)

New processes,
new surfaces . . .
. . . New Inks!

You have been using Higgins American Waterproof India Ink (4415) on absorbent tracing cloth. Now the water repellent surfaces of new cloths and foils require inks which work with all of your instruments on these new surfaces.

HIGGINS
supplies this need with . . .

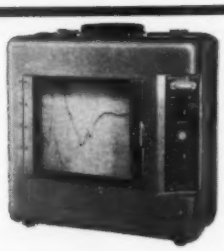
4425
Non-Waterproof Black
Removable from plastic film by water.

4435
Waterproof Acetate Black
Waterproof on plastic film and water-repellent drafting surfaces.

The basic art medium since 1880

John Gianella '08,
Executive Vice President

HIGGINS INK CO., INC. *Brooklyn, N.Y.*



ES 130
SURVEY
DEPTHOMETER

For salvage, submarine survey and channel inspection . . . all-purpose. Completely portable, lightweight . . . four scale ranges 0/65 feet, 60/125 feet, 120/185 feet and 180/245 feet. Accuracy ± ½ of 1%. Operates on 6 or 12 volts DC or 115 volts AC. Single transducer. Base price **$1175.**

UNDERWATER TV CAMERA

Completely portable 3-unit Closed Circuit TV specially designed for depths to 180 feet. Diver holds camera (approx. 4 lbs. submerged) relays continuous high definition picture to Monitor screen on boat or land. Complete with surface Control Unit. Approx. **$4,000.**

W. C. BLAISDELL
Manager, Sales & Service
VI-A '24

Brochures Mailed on Request • All Prices F.O.B. New York

BLUDWORTH MARINE

Division of KEARFOTT COMPANY Inc.
1500 Main Avenue, Clifton, N. J.
A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

Established 1929

A. M. KINNEY, INC.
Consulting Engineers
Cincinnati & Columbus, Ohio
New York, N. Y.

Complete, professional services in such fields as mechanical, electrical, civil, structural, sanitary, and hydraulic enginering. Architectural services incident to building design.

M.I.T. alumni associated with our organization:

- ☐ Russel W. Bandomer '36
- ☐ Charles H. Burchard '38
- ☐ Herbert J. Connington '42
- ☐ Alfred H. Hunter '48
- ☐ Herbert G. Keating, Jr. '46

OBLIGATIONS OF THE SCIENTIST

(*Concluded from page 514*)

There are many of you who are not citizens of this country – many who represent other lands – yet what I have had to say can with very little alteration be applied to any of you. In the first place, each of you must know that science and freedom defy national boundaries. Moreover, no nation represented here today by a graduate can escape the effects of the forces and challenges we have outlined.

Interests of the Free World

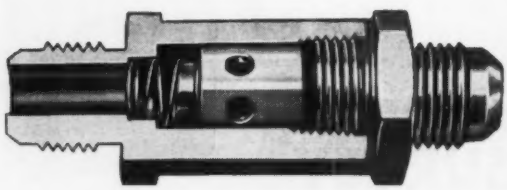
The free world's interests are so intertwined and interrelated that the elite of all nations *must* become involved. I dare say that the responsibilities of which we have spoken may bear even more heavily on some of you by very reason of the fact that there may be a greater scarcity, in the lands from which you come, of people trained as you have been trained at M.I.T.

Certainly all of us together face the needs of an ever more demanding world. Far from being on the verge of a life of greater leisure and a three-day week, I think we may well face not shorter hours, but longer and better filled ones. In short, a more exacting life in all respects than we have been led to believe was just about to be our lot. It is not an easier road that we have ahead of us. It is a more difficult one, but also a more promising and satisfying one. To explore it may well call for a shift in priorities among things we *have* heretofore taken for granted. We may have to forego some of the gadgets of life in the pressing search for more fundamental values.

Every Commencement Day speaker is expected to speak of the promises of the future. He is usually impelled to say quite truthfully that the future holds greater and more exciting challenges than ever faced the past. This is one of those things which a famous teacher at the Harvard Law School used to say were similar to the utterings of Balaam's ass – absolutely true but presupposing no conscious intelligence on the part of the being from which they proceeded. *Of course*, the future is going to be more challenging than the past, but I think we can be a little more specific in respect of this audience – you, by very reason of the galloping progress of the science this Institute and your degrees symbolize, are going to be held to higher, and more immediate responsibilities than your predecessors have ever been. All men are going to have to assume larger burdens of responsibility, but most of all it will rest on the elite of whom the scientists and technicians are now in the front rank. It is in you and those like you that there resposes the solemn obligation to undertake, even if you never achieve it, the final synthesis of knowledge and social action.

I conclude merely by saying that we have no reason to be doubtful or fainthearted about our awesome prospect. We must, however, not take *ourselves* for granted.

KOHLER
PRECISION CONTROLS



Powerful Rocketdyne liquid propellant engines for the "Atlas", "Thor", "Jupiter", "Redstone" and other mighty missiles for America's defense—are served by Kohler check valve K-1359.

This 3000PS1 soft seat type valve can be supplied with any type of connection. The "O" ring, held in place by a specially designed retainer, cannot be washed out of position by high surge pressure.

Kohler Precision Controls include a full line of valves for control of hydraulic, gasoline, lubricating oil, water, chemical, air and vacuum lines.

Our engineers develop valves and fittings to specifications for volume production. Write for information.

Static test stand where power developed by rocket propulsion engine is measured.

KOHLER CO. Established 1873 KOHLER, WIS.

KOHLER OF KOHLER

Enameled Iron and Vitreous China Plumbing Fixtures • Brass Fittings • Electric Plants • Air-cooled Engines • Precision Controls

rities
nted.
f life
lues.
ed to
ually
nolds
aced
mous
were
utely
e on
eded.
nging
more
very
this
ng to
ibili-
men
f re-
elite
w in
that
take,
is of

eason
some
s for

for
nd
ure

ed
in
be

of
ng

to
in-

ols

REVIEW

When you need

a tough fan for a tough job...

INDUSTRIAL PROCESSES

BOILER GAS RECIRCULATION

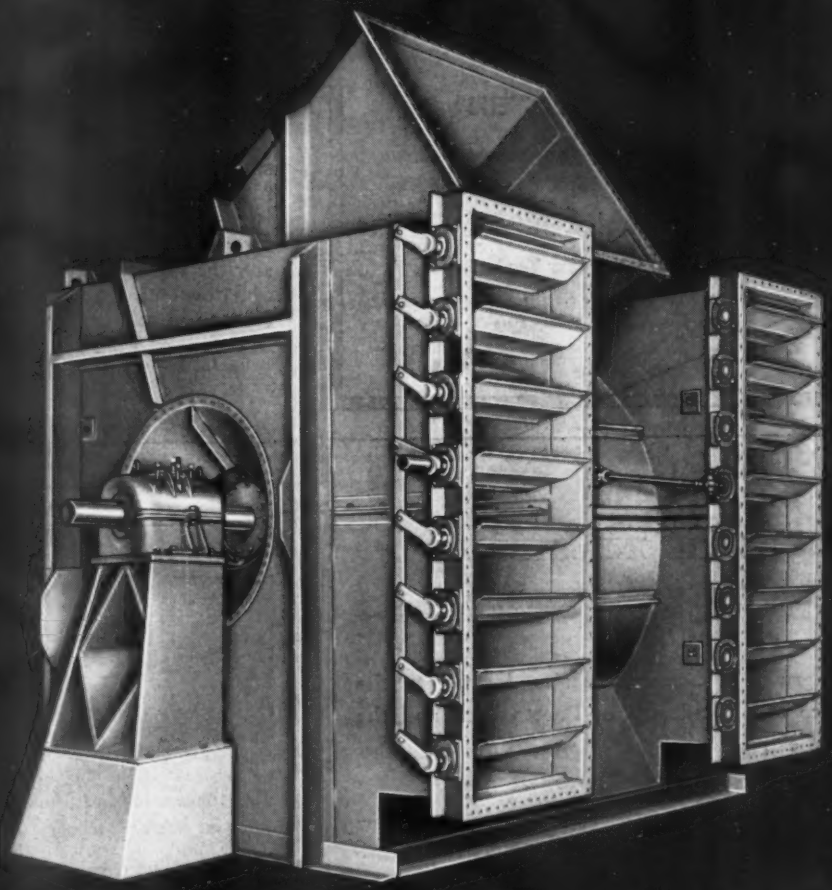
ORE SINTERING EXHAUST

ROTARY KILN EXHAUST

BLACK LIQUOR INDUCED DRAFT

WASTE HEAT INDUCED DRAFT

STEEL MILL FURNACE CIRCULATION



Westinghouse offers you a Heavy-Duty Fan...
the right type...the right size...the right blading

Call your nearest Sturtevant Division Sales Engineer, or write Westinghouse Electric Corporation, Dept. G-23, Hyde Park, Boston 36, Massachusetts. J-80662

YOU CAN BE SURE...IF IT'S Westinghouse

DEXTER CHEMICAL CORPORATION

Pioneers in the study of static electricity on textiles . . . Specialists in processing agents for cotton, wool and all synthetics.

AZEL W. MACK
New England Sales Manager
M. I. T. 1915

SIDNEY M. EDELSTEIN
President
M. I. T. 1932

DEXTER CHEMICAL CORPORATION
845 Edgewater Road, New York 59, N. Y.

BOSTON, MASS. • GREENSBORO, N.C. • CHARLOTTE, N.C.
ATLANTA, GA. • BUENOS AIRES

REPORT OF THE INSTITUTE

(*Continued from page 482*)

live in a civilization which is not only dominated by science and technology, but has become overwhelmingly dependent upon advances in science for its survival. It is therefore imperative that we have the courage and imagination to innovate, and, when necessary, to break with tradition.

In his Alumni Address of June, 1957, Dr. Killian pointed out that the founding of M.I.T. came about in part as a protest against the rigidities, the frozen classical formulas of then existing institutions. We in turn must be watchful that in our current educational processes we do not become prisoners of a rigidity and classicism of our own making.

The present national crisis in engineering education has come about principally because engineering itself has passed out of the stage of simple technology into a domain of enormously complex problems. To cope with this situation, engineers – or at least some engineers – must have a great command of mathematics and basic physics and chemistry. This is patently true of those who are destined primarily for research, but it is becoming increasingly a necessity for those who are to be concerned with design and development. To meet this need, we have tended constantly to increase our requirements on the side of theory and mathematical analysis. We see no way

(*Continued on page 520*)

FERRÉ INDUSTRIES
(EMPRESAS FERRÉ)

A group of basic industries devoted to the service of all industry in Puerto Rico and the Caribbean region.

Sugar mill machinery—cement—glass bottles—clay products—ceramics—asbestos-cement products—pulp and paper products—concrete products.

Under the direction and management of the Ferré family, which includes two MIT alumni:

Luis A. Ferré, B.S., M.S.—1925
Herman Ferré, B.S.C.E. —1931

JUST REPRINTED

NEW • ENLARGED • REVISED EDITIONS OF

Smoley's Tables

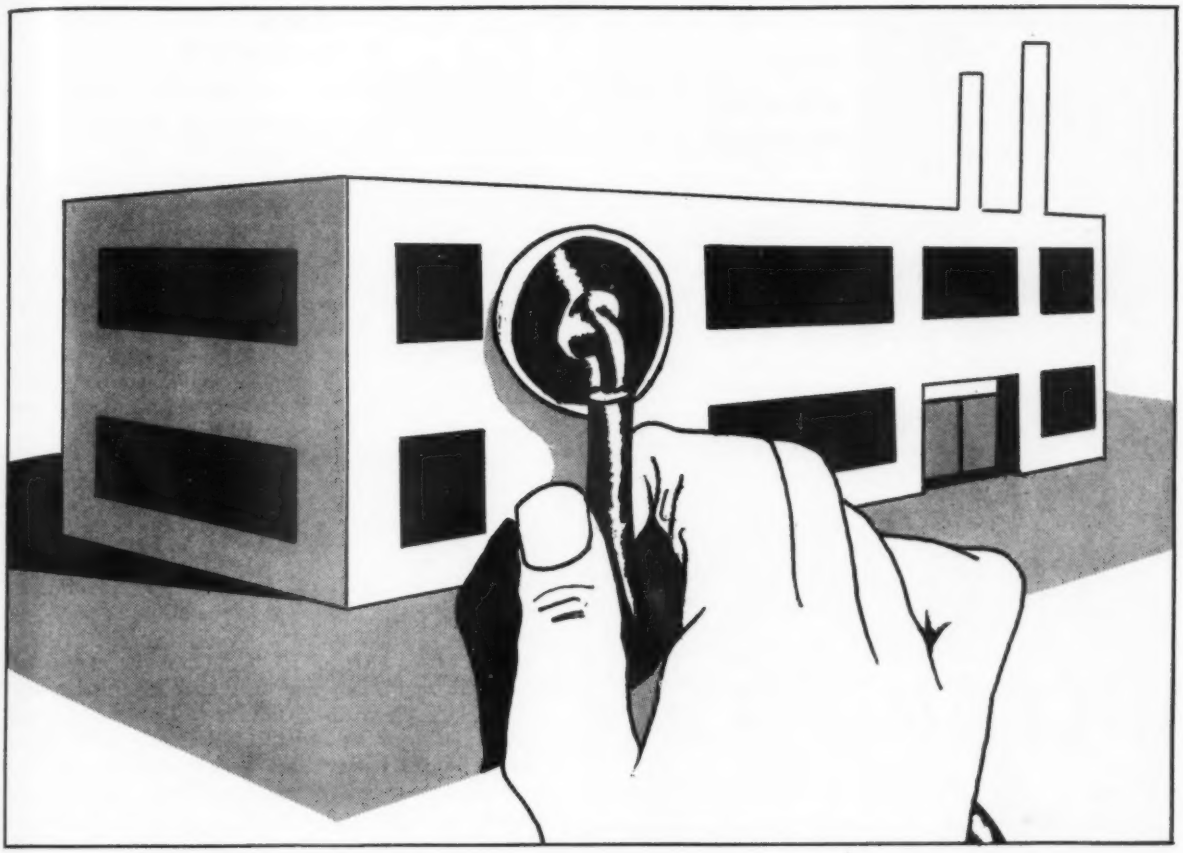
350 New Pages

Time Savers for Designers & Builders since 1901. Check items of interest to you:

☐ Logs and Squares Parallel Tables increased 100′ to 300′	**$ 6.00**
☐ Slopes & Rises (Tables doubled) 192 bevel pages increased to 384	**6.00**
☐ Log. Trig. Tables areas and circumferences extended	**1.50**
☐ Three Combined Tables	**10.00**
☐ Segmental Functions	**5.00**
☐ Four Combined Tables	**12.00**

Mail Orders & Inquiries to:

C. K. Smoley & Sons, Inc.
P.O. Box 14, Chautauqua, N. Y.



Could YOUR Plant Pass a "Physical"?

Fire, explosion, and breakdown are some of the major ills that strike industrial plants — and any one of them usually means costly repairs or even a shutdown.

Just as in the case of human beings, however, periodic check-ups can be most effective in locating and eliminating trouble spots before a serious condition — or even a disaster — builds up. Made by trained engineers and inspectors who are equipped with the most modern testing equipment, such regular inspections are a service offered free of charge to all our policyholders. They share, too, in all the benefits of our extensive laboratory research; and through our publications their employees are kept constantly on the alert as to safe engineering practices.

As you might expect, this highly developed loss-prevention program is most effective; and as a result, our insureds enjoy the double benefits of security and lowered insurance costs.

Specialists in plant protection for over one hundred years, our two companies are playing a major role in keeping American and Canadian industry in operation. Why don't *you* join our ever growing list of satisfied policyholders? Just write or phone us and we'll be glad to provide additional information — without any obligation on your part.

Boston Manufacturers Mutual and Mutual Boiler and Machinery Insurance Companies

225 WYMAN STREET, WALTHAM 54, MASSACHUSETTS

M. B. DALTON	'15	G. M. RODDY	'31	R. H. ROBINS	'50
G. A. SHATTUCK	'22	R. HARRIS	'37	F. J. BUMPUS	'51
W. W. K. FREEMAN	'22	R. L. JOHNSON	'38	J. L. GANGER	'51

GEARS

Made to Your Specifications

You and we can form a team—you to draw up the specifications; we to make the gears—that will be profitable to both of us. Gears of all types, all sizes, all materials. Design-engineering service available.

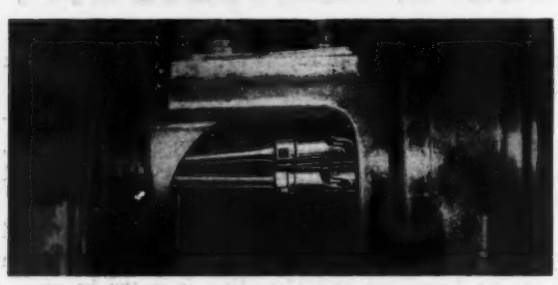
Custom Gears Exclusively

DIEFENDORF GEAR CORPORATION

Syracuse 1, N. Y.

DIEFENDORF GEARS

Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint. **The solution** was a Curtis Universal Joint of the same size but higher torque.

This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK
3/8" to 4" O.D.
(6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**
UNIVERSAL JOINT CO., INC.
8 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

REPORT OF THE INSTITUTE

(*Continued from page 518*)

to escape this course if an institution such as M.I.T. is to fulfill its particular mission.

But there are very serious consequences to such a trend of which many of the most thoughtful members of our Faculty are acutely aware. It has been affirmed repeatedly that engineering and science are by no means one and the same. The methods and the materials of engineering and science increasingly overlap, but the aims and the functions differ profoundly. The scientist is concerned primarily with understanding, with deepening our knowledge of the laws and operations of the physical world. The engineer must be concerned with how this knowledge may be applied for the welfare of society – for the usefulness of mankind.

Now it is clear that a twilight zone exists between science and engineering where it is difficult to tell which of these two motivations predominates. Moreover, within the several branches of engineering themselves there are other profound differences in character.

As Professor [Edwin R.] Gilliland ['33] reported to you this morning, we are in a mood to experiment with new curricula. But there is still unresolved the dilemma of how we are to select students of engineering who have both the capacity to deal with the mathematical complexities of research and systems design, and an innate sense of the public responsibilities of the engineer. It is by no means clear that these interests can be fully developed in the same individual. There is a real concern lest the selection process that brings to us the most gifted analytical minds may screen out boys with other potentialities no less precious to the future of this country.

And now while I am still on the subject of education, I should like to speak for a moment of the great need of developing for our undergraduates a truly residential college. M.I.T. is and will remain an urban institution. It once had the choice of being a day school for boys, or a university in the true sense. We became convinced that an institution composed entirely of commuters could never provide the educational experience that comes from living together on a campus. This conviction underlies the rapid extension of our dormitory system following World War II with the addition of Baker and Burton Houses.

During the past year several important further steps have been taken. Next fall we will witness the expansion of a resident housemaster plan in Burton House. Professor Howard R. Bartlett, Head of the Department of Humanities, Mrs. Bartlett, two junior Faculty members, and several graduate students will become integral members of the House, with the avowed purpose of guiding and strengthening its social and educational life. I am confident that in due course of time we shall be able to extend this plan to other dormitories.

Equally important in fashioning this residental life of the Institute is our athletic program, under Pro-

(*Continued on page 522*)

Robert Leventhal '36
Norman B. Leventhal '38
Albert W. Parsons Jr. '41
Stanley H. Sydney '52
Sanford A. Kaplan '52
Harvey Steinberg '54

BEACON CONSTRUCTION COMPANY
of Massachusetts, Inc.

BUILDERS

102 Hano Street Boston 34, Mass.

GAS STANDBY

Packaged 12 mcfh plant designed and built by Draketown for...

- ★ Utility or Industrial standby
- ★ Peak shaving and augmentation
- ★ 100% Town or plant supply

A Packaged Draketown Propane Plant will help you reduce demand charges; provide a supply of gas during curtailment periods... at the turn of a valve... or supply that outlying section or plant 100% if desired.

DRAKETOWN® PROPANE PLANTS
"Good Gas Insurance"

If you have a gas problem, we can help you. We operate from coast to coast and overseas.
Phone or write today—no obligation.

DRAKE & TOWNSEND
Consulting • Design • Engineering • Construction
11 WEST 42ND STREET • NEW YORK 36 N. Y.

AT YOUR SERVICE

SPECIALIZED ENGINEERING
SPECIALIZED EXPERIENCE
SPECIALIZED MACHINERY
FOR
TWISTING · FORMING
STRANDING · BUNCHING
COTTON · JUTE · MANILA
SISAL · NYLON · DACRON
ORLON · SARAN · PAPER
POLYETHYLENE · GLASS

TEXTILE · WIRE · CORDAGE
and OTHER INDUSTRIES

HASKELL-DAWES
MACHINE CO., INC.
2231 E. Ontario Street
Philadelphia 34, Pa.

GERHARDT F. MEYNE COMPANY
BUILDERS

Commercial & Industrial Construction

DONALD W. FETTERS
XVII '32
President

308 W. WASHINGTON ST.
CHICAGO 6, ILL.
FINANCIAL 6-3377

NOW...

Even More
Heat-Exchange Capacity
Even Less **Air Friction**

with *AEROFIN*
Smooth-Fin
Heating and Cooling Coils

Write for Bulletin S-55

AEROFIN CORPORATION
SYRACUSE N. Y.

FREE BOOKLET TELLS WHAT CO_2 CAN DO FOR YOU

agriculture
chemistry
metals
electronics
refrigeration
food
drugs
textiles
rubber

There's practically no end to the important jobs that CO_2—combined with Liquid Carbonic savvy—is doing. Chances are this combination can come up with some surprising answers for you, too. For scores of CO_2 applications, covering all industry, send for LIQUID's new free booklet, "Applications Unlimited." Just use the coupon below.

MAIL THIS COUPON

LIQUID CARBONIC
DIVISION OF GENERAL DYNAMICS CORPORATION
3100 South Kedzie Avenue, Chicago 23, Illinois

Send me my free copy of "Applications Unlimited."

Name_____
Company_____
Position_____
Address_____
City_____ Zone____ State_____

REPORT OF THE INSTITUTE

(*Continued from page 520*)

fessor Balch, which is continually being improved, and which we are striving to incorporate even more closely into the total educational experience. Recently we began construction on the Du Pont Athletic Center, which with the addition of the newly purchased Armory on Massachusetts Avenue will give the Institute, for the first time in its history, athletic facilites commensurate with the needs of its students and staff.

Of all the work that has been going on at the Institute this past year with respect to teaching, I think that the most exciting in its implications is that of the Physical Science Study Committee, which has been planning a new kind of high school physics program.

This group of more than 100 scientists and educators, under the direction of Professor Jerrold R. Zacharias, has prepared the draft of a new textbook presenting a unified picture of the physical world from the point of view of modern physics, in addition to intensive work on films and apparatus for classroom demonstrations, a teacher's manual, and a series of low cost monographs for the student who is stimulated to read beyond the text.

This effort is far from complete, but I do feel certain of one thing—it is going to have, indeed already has had, a revolutionary effect in breaking out of some of the ruts of secondary school curricula. I would stress that the work of this Committee, representing co-operative efforts of people drawn from a wide spectrum of talents, may well represent the new kind of "break-through" in educational planning of the future. At the same time, I am also very proud that members of our own Faculty have led the way in this project.

Among the many other activities presently under way at the Institute, I should like to single out a few for particular mention.

A year ago we dedicated the Computation Center with its I.B.M. 704 Computer, giving the Institute the most versatile and up-to-date electronic data processing equipment of any college in the country. The Center has proved a major asset to our educational and research programs, touching courses given in the Schools of Science, Engineering, and Indus-

(*Continued on page 524*)

SCULLY SIGNAL COMPANY

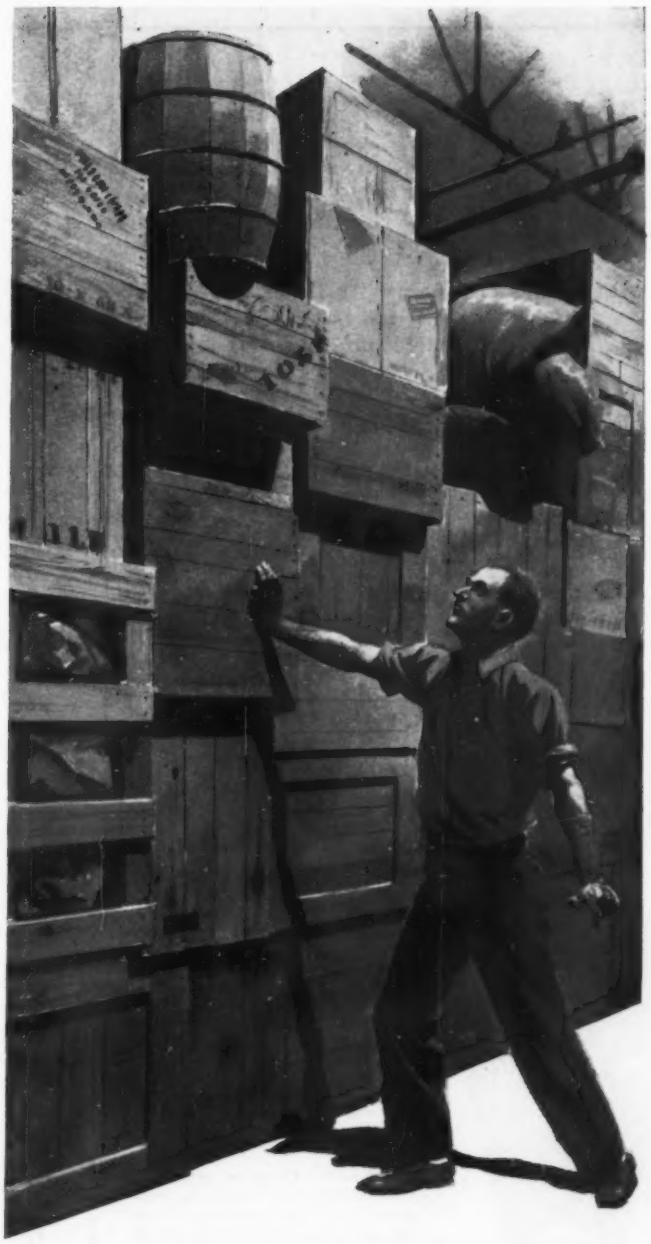
Safe Fills
No Spills
with **VENTALARM**®
WHISTLING TANK FILL SIGNAL

for automotive, home and diesel fuel tanks

F. P. Scully '15 — 174 Green Street, Melrose 76, Mass.

"JUST FILL 'TIL THE WHISTLE STOPS"

Why stack the odds against yourself?



Let's face it! The chances of a fire destroying your warehouse are more than doubled when products or materials are improperly stored.

To get to the bottom of the underlying causes of costly storage fires, Manufacturers Mutual Loss-Prevention Engineers have made thorough studies of modern storage methods. They have whittled storage hazards down to size by stressing the importance of No Smoking Rules, skidding, adequate subdivision, and limited stacking heights to permit full sprinkler efficiency.

Rather than run the risk of hazardous storage procedures such as are shown in the adjacent sketch why not talk things over with one of our experienced Loss-Prevention Engineers? Mail the enclosed card now.

Howey J. Freeman '16
PRESIDENT

Norris G. Abbott, Jr	'21
Andrew T. Johnson	'21
Francis E. Slayter	'22
Maurice W. Williams	'22
Kenneth M. Warren	'35
Roger M. Freeman, Jr.	'44
Charles F. Street	'45
Colin A. Roberts	'46

MANUFACTURERS MUTUAL FIRE INSURANCE COMPANY

1500 TURKS HEAD BLDG., PROVIDENCE 1, R. I.

Over $66,000,000,000 Insurance in Force in the Factory Mutual Companies

MANUFACTURERS MUTUAL IS THE OLDEST AND LARGEST OF THE FACTORY MUTUAL COMPANIES

New Books from *The Technology Press*

ATMOSPHERIC EXPLORATIONS
Papers of the Benjamin Franklin Memorial Symposium of the American Academy of Arts and Science
edited by Henry G. Houghton $6.50

LECTURES ON ORDINARY DIFFERENTIAL EQUATIONS
by Witold Hurewicz $5.00

A series of lectures on ordinary differential equations in the real domain, originally given in 1943 by the late professor of mathematics at M.I.T.

The TAO of Science
An Essay on Western Knowledge and Eastern Wisdom
by R. G. H. Siu $4.25

An American scientist with roots in the Orient comments on western philosophy and American educational and business methods.

Published jointly with
John Wiley & Sons
Order from your Bookseller
or

The Technology Press of M.I.T.
Cambridge 39, Mass.

SPECIALISTS in Pre-Fabricating PIPING

STEEL PIPE: Wrought Iron • Steel • Structural • Cast Iron • Copper-Steel • Electric Weld • Seamless • Spiral, Lap & Butt Weld • Shore-Dredge • Speed-Lay

CEMENT-ASBESTOS PIPE: For sewerage and water mains where corrosion is a problem.

ALUMINUM PIPE: In standard and light walls. All accessories stocked.

PLASTIC (PVC) PIPE

SPEED-LAY: Complete packaged PIPE SYSTEM for fast-laying, temporary and semi-permanent lines for water, compressed air and other services. Write for catalog.

VALVES, FITTINGS & FLANGES: Tube Turns • Dresser • Victaulic • Cast Iron or Steel • Forged Steel • Special Alloys • Water Main

PILING PIPE: Cast Steel and Iron Points • Plates and Shoes • Cast Steel • Malleable Iron Sleeves

COMPLETE FACILITIES for Bending, Coiling, Beveling, Swedging, Flanging, Grooving, Welding, Cutting to Sketch, and Threading to most rigid requirements. Bitumastic or Cement lining — Testing — all to Standard specifications.

S.G. ALBERT '29 • A.E. ALBERT '56

ALBERT PIPE SUPPLY COMPANY, INC.

103-1 VARICK AVE., BROOKLYN 37, N. Y.
Tel.: HYacinth 7-4900

REPORT OF THE INSTITUTE

(*Continued from page 522*)

trial Management. I think it is fair to state that there is hardly an area of research at the Institute that is not making some use of the Center. We have been delighted to share this facility in training of students and faculty from other New England colleges and universities.

Secondly, let me report that our already extensive work in Nuclear Engineering has been brought together in a graduate department under the direction of Professor Manson Benedict ['32]. With the completion of the nuclear reactor within the next few weeks, the Institute will be prepared to offer the best of advanced training in the theory and applications of nuclear energy. While current teaching and research is concentrated on the fission process, the department will ultimately develop parallel work in thermonuclear fusion. It should be reported that among the many expected uses of the reactor, serious attention will be given to advanced medical and clinical research.

Thirdly, I should like to report the establishment of a Center for Urban and Regional Studies to carry out basic research on the nature, characteristics, and problems of the urban community. By co-ordinating such research with technical specialties of the Institute, it is expected that much can be done to help solve some of the physical ills that are besetting urban areas across the nation.

Next, I should mention the recent establishment of the Center for Communications Sciences for exploring communication functions of the human nervous system and of machines, such as computers. This is an area in which M.I.T. has long enjoyed preeminence, and some of the pioneers and truly great names in the field — Vannevar Bush ['16], Norbert Wiener, Claude Shannon ['40], Jerome Wiesner — are here at the Institute. Our center will give new scope and support in this field to a collaboration among mathematicians, physicists, electrical engineers, linguists, psychologists, and physiologists. I think that without doubt it will lead to a new understanding of communication theory, and to more effective use of machines. More broadly, continued research here may ultimately lead to progress in such diverse fields as group communications, indus-

(*Concluded on page 526*)

"Precision-Gauged"
HAIRSPRINGS
More than 25 years' experience making all types of hairsprings for critical instrument applications. High volume production with absolute uniformity.

PRECISION PRODUCTS COMPANY INC OF WALTHAM
WALTHAM 54 • • MASSACHUSETTS

STANDARD OIL COMPANY

(INDIANA)

910 South Michigan Avenue . . . Chicago 80, Illinois

WHEELER CONSTRUCTION CO.

BUILDING CONSTRUCTION

EARL C. WHEELER '26 — IAN H. MACDONALD '48

15 LEWIS STREET — HARTFORD, CONNECTICUT

REPORT OF THE INSTITUTE

(*Concluded from page 524*)

trial management, social behavior, and medical health.

Finally, in another area which is emerging as one of great national importance, that of materials, we are consolidating our resources. This summer a task force of our Faculty under the direction of Professor Morris Cohen ['33] will begin a systematic study of the entire field of materials, including subject matter, method of teaching, and the objectives of research. An interdisciplinary approach of solid state physics, chemistry, metallurgy, ceramics, and other fields may well give answers to the complex problems of the essential nature of materials.

Faculty Salary Support

I have only touched upon the high lights, but I am certain all these developments are as gratifying to you as they are to us. Underlying their success are the quality and loyalty of our Faculty. To provide adequate remuneration for our teachers has been a major concern throughout the past year. It was just a year ago that Dr. Killian announced that the Institute was beginning a special and concentrated drive to secure funds for the support of our Faculty salaries. You will recall that the Sloan Foundation, backed by the unfailingly generous assistance of our Alumnus, Alfred P. Sloan, Jr., '95, offered a grant of one and a quarter million dollars toward a five million dollar fund for Faculty salaries, provided the Institute obtained the remaining three and three-quarter million dollars from other sources.

To meet this challenge, an all-out effort under the leadership of Walter J. Beadle, Class of 1917 and a life member of the Corporation, has been conducted throughout the past year. I know that it is one of Jim Killian's major disappointments that his call to duty in Washington came before he was able to see the campaign to completion, but I am delighted to announce that we are now in sight of our goal – that the five million dollar target is so nearly reached that we have taken a major step and have now granted to our Faculty members substantial selective increases in salary.

The success of this "crash" program is due to the countless number of Alumni and friends of the Institute who have rallied to its aid; but if one person has been responsible, it is Walter Beadle. He has devoted not only countless hours, but also an immeasurable amount of his energy in giving personal direction to every step of the campaign. There could be no warmer note on which to close than to say to you, Walter – and through you to our fellow Alumni – thank you for all that you have done.

CHAS. T. MAIN, INC.

Design of Industrial Plants
Pulp and Paper Mills
Steam, Electrical and Hydraulic Engineering
Machinery Reorganization — Water Supply
Investigations, Appraisals and Reports
Construction Management

Boston, Mass. — Charlotte, N. C.

LET ME HELP YOU

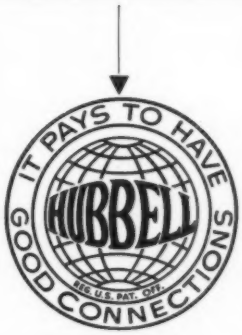
IN FLORIDA

R. W. Caldwell, Jr. '43

R.W. Caldwell INC. REALTOR

Real Estate, Building, Insurance

3119 Beach Boulevard, Gulfport, Fla.



RUGGED WIRING DEVICES,

precision machine screws and fasteners

HARVEY HUBBELL, INC.
Bridgeport, Connecticut

G. R. WEPPLER '37

The TREDENNICK-BILLINGS CO.

Construction Managers — *Building Construction*

K. W. RICHARDS '07 — H. D. BILLINGS '10 — C. C. JONES '12 — F. J. CONTI '34

10 HIGH STREET — **BOSTON, MASSACHUSETTS**

CASTLE

RUBBER COMPANY

BUTLER, PENNA.

Manufacturers of

Rubber Specialties

Molded-Lathe-cut-Roll Coverings

Made to

Customer Specifications

H. E. Heiligenthal '34, V.P.

FOR THE BEST
IN

CONTRACT DIAMOND DRILLING

EXPLORATORY CORE DRILLING
(surface-underground)

BLAST HOLE DRILLING

FOUNDATION TEST DRILLING

GROUT HOLE DRILLING

PRESSURE GROUTING

LEADING ENGINEERING FIRMS
ARE CONTACTING

SPRAGUE & HENWOOD, INC.
221 W. Olive St., Scranton, Pa.

A. E. Ross '34 • L. W. Jansen '48 • S. B. Jones '51

RESEARCH IN UNDERGRADUATE ENGINEERING EDUCATION

(*Continued from page 490*)

what should be done under such a program. The Institute has received a grant from the Carnegie Foundation to finance this study. Professor Cohen of the Department of Metallurgy will head a group that will study what the Institute can do to give leadership in the materials field. This is an area that is important to all engineers. It is an area that has been developing rapidly with our increased knowledge of the solid state and of plastics. We believe it needs to be integrated to give all engineering students a better understanding of this important area. Professor Cohen's group will also consider how M.I.T. should organize to give leadership in this field. The Institute has also obtained financial support for this study. We believe that these two studies will have an important bearing on our future educational program at M.I.T., and we are very hopeful that during the coming year we will be able to organize studies in several of the other common areas. I am sure that in the future you will be hearing and seeing the results of this work.

A number of other suggestions for improving our educational program have been made. For example, a frequent suggestion is the tutorial system. In general, it implies a closer personal relationship between the teacher and the student. We know this would be desirable. This desirable feature is generally countered by stating that it is so expensive that it cannot be considered as an educational method for a school the size of M.I.T. We believe that the technique of obtaining the real benefits of such a system can be developed at a cost that is feasible. For example, one of the supposed benefits of such a system is the fact that it will make the student and the teacher or tutor partners in making the educational progress as rapid as possible instead of having the student look upon his professor as his inquisitor and judge. We are planning an experiment whereby a limited group of our students will be given a tutorial type of program, and from this we should be able to determine whether this is desirable as compared with our present methods. This emphasizes one of the major problems in experimentation, and that is in the evaluation of the results. In the scientific area, when the experiment is carried out, in general, most of those trained in the field will agree upon the result. In the field of education, it is very difficult to get agreement upon the result or the significance of an experiment.

(*Continued on page 530*)

William H. Coburn & Co.
INVESTMENT COUNSEL
68 Devonshire Street
Boston

THE DWIGHT BUILDING COMPANY

General Building Contractors

HAMDEN 14, CONNECTICUT

G. VINCENT MACONI '15
President

RICHARD C. MACONI 2-'44
Vice President

ENGINEERS, FABRICATORS AND MACHINISTS OF EQUIPMENT IN

STAINLESS STEEL, INCONEL, MONEL, ALUMINUM AND ALLOY STEELS

FOR THE

AIRCRAFT, ELECTRONIC, CHEMICAL AND ATOMIC ENERGY INDUSTRIES

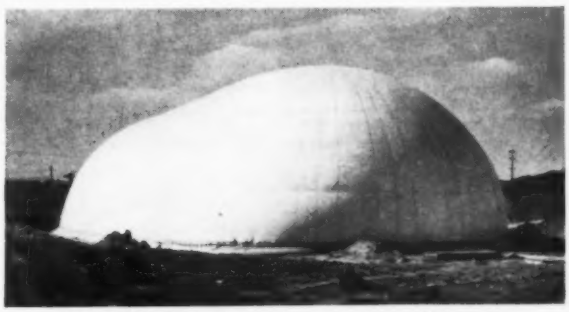
ASME CODE PRESSURE VESSEL FABRICATION

PROCESS EQUIPMENT CO., INC.

Designers and Builders of Chemical Process Equipment

71 FOREST ST. BROCKTON, MASS.

EARL I. MEYERS '41 - PRESIDENT



"BUILT" in one hour

This new air structure by HOOSIER can be erected and taken down in one hour.

Available in sizes from 20x30—10 feet high to 60x120—30 feet high, it is completely supported by low air pressure, leaving the floor completely free of obstructions.

Perfect for temporary outdoor storage and "climate control" for construction projects.

Hoosier

TARPAULIN & CANVAS GOODS CO. INC.

1302 W. Washington St., Indianapolis, Ind.

M. Stanley Goldberg, '52 Vice-President

FERGUSON ELECTRIC CONSTRUCTION CO. INC.

BUFFALO, N.Y.

WHITWORTH FERGUSON '22
BURNS M. GREGG '50

Sangamo Electric Company offers you an exciting and challenging career

Other MIT graduates* have found satisfying opportunity and fitting rewards with Sangamo—a pioneer manufacturer of electric metering apparatus and control equipment. Sangamo has steadily grown in stature since 1899, through sound, progressive management; engineering vision; and an outstanding reputation for quality of products. These include electric meters, power capacitors, time switches, dynamotors, generators, electronic capacitors, recording instruments and military equipment. Besides the main plant in Springfield, others are situated at Pickens, South Carolina, and in Canada, England and Scotland.

Now is the time to inquire about your opportunity at Sangamo. Ask your college placement officer or write directly to Sangamo's Training Director.

* These MIT men hold important and worthwhile positions with Sangamo Electric Company:

Edward A. Leach, class of 1927
Vice-president in charge of Engineering

Roy Ide, class of 1930
Chief Chemist, Pickens Division

Herbert Johnson, class of 1943
Chief Engineer

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS, U.S.A.

RESEARCH IN UNDERGRADUATE ENGINEERING EDUCATION

(*Continued from page 528*)

Last year, Edwin H. Land gave the Arthur D. Little Lecture at M.I.T., and for this he made a study of our undergraduate work. He believed that for many of our students greater motivation and consequently greater educational progress could be obtained if the early years gave more of an opportunity for research work by students. He suggested that each entering student should be assigned to a research project with a staff member, and that in working in the laboratory with experienced men, the student would find he needed information and background in various areas such as mathematics, physics, chemistry, and that he would then go to the library, to classes, or to lectures to obtain the necessary information. In this way, he would have the motivation to learn his science and engineering. Dr. Land, as part of his program, suggested that M.I.T. should put a large amount of lecture and course work on film, and that the Institute should have facilities such that a student could see and listen to such material whenever he chose. Our committee plans to look at some type of an experiment in which greater emphasis would be placed on research in our undergraduate program. We have not concluded that we want to go as far as Dr. Land suggested; but we would like to see an experiment, with a limited group of students, in which research work was a more important aspect,

(*Concluded on page 532*)

You Can Have Highest Quality Tool Hardening

Sentry Electric Furnaces in combination with the Sentry Diamond Block method of atmosphere control produce the finest quality high speed steel hardening at amazingly low cost.

The truly neutral atmosphere created by the Sentry Diamond Block unfailingly prevents scale or decarburization on all types of high carbon high chrome or tungsten, molybdenum or cobalt high speed steels at hardening temperatures.

Write for the Sentry catalog for details of the range of Sentry furnaces and the function of the Sentry Diamond Block.

Request Catalog M

Sentry TRADEMARK **ELECTRIC FURNACES**
THE SENTRY CO., FOXBORO, MASS.

Also manufacturers of reliable high temperature tube furnaces designed for many laboratory or industrial procedures including processing of semiconductor materials. 232-8

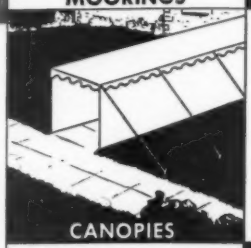
TAYLOR ELASTIC CORD

TENTS

. . especially designed for better protection and economical handling of many products.

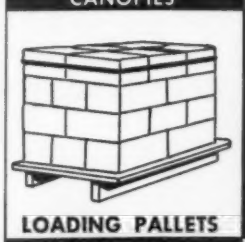
MOORINGS

PARACHUTES



CANOPIES

BAGGAGE TRUCKS



LOADING PALLETS

TRAILER TIEDOWNS

COVERS FOR FARM MACHINERY

TRUCK LOADING

Thomas Taylor elastic cords and webs have unlimited potentialities in many fields. Elastic Shock Cord, originally developed for the armed forces and aircraft industry, is also ideal for tent guy ropes, tiedowns on truck tarpaulins, and holding fragile loads safely in place, by exerting and maintaining constant elastic tension.

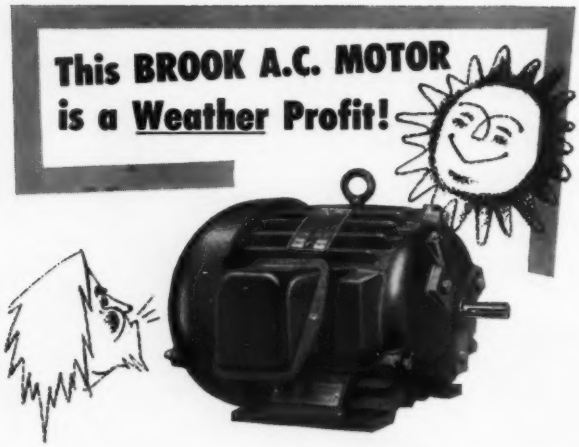
Our engineers are ready and eager to study the handling problems of your particular product. It is quite likely that versatile shock cord, in one of its many sizes, will mean economies for you, by saving valuable time and by protecting your merchandise from transportation damages.

TARPAULINS

THOMAS TAYLOR & SONS

HUDSON, MASSACHUSETTS

ROBERT TAYLOR DAWES
Class of 1926



Peak performance in all climates—humid or arid—high or low temperatures. You *profit in any weather* with this husky, totally enclosed, fan cooled BROOK MOTOR. Yet, it actually *costs less* than an ordinary, light duty motor. Slip Ring or Squirrel Cage type, 1 to 600 H.P., ready for shipment from warehouse stocks in major industrial centers. Send for brochure and name of your local Brook Dealer.

world's most respected motor

BROOK MOTOR CORPORATION

3553 W. PETERSON AVE., CHICAGO 45, ILLINOIS

Peter L. Loewe, Pres. '31

SINCE 1904 BROOK MOTOR CORPORATION

RESEARCH IN UNDERGRADUATE ENGINEERING EDUCATION

(*Concluded from page 530*)

perhaps even the central theme, of their undergraduate program. We believe that it would be desirable to have a group of students begin and carry out this type of system for the four years.

In discussing some of the early experiments, I indicated the increased emphasis on science. Others of our staff are in favor of introducing the engineering viewpoint and method at a much earlier stage. For example, the Civil Engineering Department has proposed a program in which the engineering and scientific training would go along in parallel throughout the four years instead of the series arrangement now employed, in which the early years are largely given to science and the latter to the more professional work. This proposed type of arrangement we call "vertical integration." We would like to see the Civil Engineering Department give it an enthusiastic test. Professor Holt Ashley ['48], who is the next speaker, will discuss an educational approach favored by the Aeronautical Engineering Department.

A number of other types of experiments have been suggested, but those I have mentioned give you some idea of the approach we are planning. Such a program can make a real contribution to engineering education. The time and effort spent on such work will generate many additional ideas, and the enthusiasm of the staff groups will be carried over to the students. We look forward to a very stimulating and interesting period in the Engineering School.

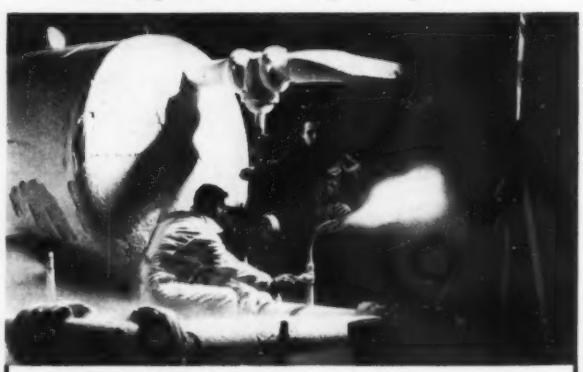
SUCCESSFUL
Plant Manager

gets rid of his electrical plant maintenance problems and the high hourly cost of shut-downs. He also puts complete responsibility for electrical construction work in the hands of

A. J. WOLFE COMPANY

2 Harris Avenue, Jamaica Plain
(Boston) 30, Massachusetts

Call JAmaica 4-1222 . . . Our 35th Year



FIRST WITH HIGH-FLOW COLD-FLOW

LIQUID OXYGEN (OR NITROGEN): TO 8000 gpm
GASEOUS OXYGEN (OR NITROGEN): TO 40 lbs/sec

Wyle is the first independent testing laboratory to offer cryogenic facilities for full-scale, actual-media testing of propulsion and ground support components for large ballistic missiles.

WYLE LABORATORIES • El Segundo, Calif.

Frank S. Wyle '41

FORTÉ-FAIRBAIRN INC.
FORTÉ ENGINEERING CO. DIV.
59 DAVIS AVE. NORWOOD, MASS.

ELECTRONIC MOISTURE CONTENT
ANALYZERS

for

textiles
foods
paper
plastics
chemicals
construction materials

Bob Fairbairn '39
Stan Breen

ROCK OF AGES®

GRANITE

for monuments
markers
mausoleums
sculptured work
curbing
building & construction
precision surface plates
(Bryant-Rock of Ages)

R. S. GILLETTE,'36 *President*
C. Y. FERRIS, Jr.'47 *Chief Engineer*
ROCK *of* AGES • BARRE, VT.

HART PRODUCTS
BASED ON RESEARCH

"Chemicals for Every Phase
of Textile, Paper and Leather Processing"

Ralph Hart M.I.T. '15
Morris B. Hart M.I.T. '21
E. I. Birnbaum M.I.T. '30

The Hart Products Corp.
1440 Broadway, New York 18, N. Y.

RAYMOND
INTERNATIONAL INC.

FORMERLY RAYMOND CONCRETE PILE COMPANY

Executive Offices:

140 CEDAR STREET • NEW YORK 6, N. Y.
Telephone CORTLANDT 7-7070
Cable Address RAYMONDINT

Offices in Principal Cities in the United States

FOUNDATIONS FOR THE STRUCTURES OF AMERICA
... COMPLETE CONSTRUCTION SERVICES ABROAD

HOLMES & NARVER, INC.

ENGINEERS • CONSTRUCTORS

JAMES T. HOLMES M.I.T. '14
D. LEE NARVER STANFORD '14

828 S. Figueroa St., Los Angeles 17, California
Telephone MAdison 7-4337

SYSKA & HENNESSY, INC.

Engineers

John F. Hennessy '24 John F. Hennessy, Jr. '51

DESIGN • CONSULTATION • REPORTS
POWER PLANT • WASTE DISPOSAL • WATER SYSTEMS
New York City

CHAUNCY HALL SCHOOL

Founded 1828. The School that specializes in the preparation of students for the Massachusetts Institute of Technology.

Ray D. Farnsworth, *Principal* 533 Boylston Street, *Boston, Mass.*

ALEXANDER KUSKO, INC.

Consulting Engineers

141 Main Street Cambridge 42, Mass.
ELiot 4-4015

Research and Development in

Magnetics
Electric Machinery

Transistor Circuits
Control Systems

A. Kusko '44
P. N. Heller '51

J. P. Blake, Jr. '54
J. A. Gaudet '56

LOCKWOOD GREENE
ENGINEERS—ARCHITECTS

Professional Service from Site Selection to Plant Completion

Plant Location Studies
Site Investigations
Complete Design
Supervision of Construction

REPORTS APPRAISALS

New York BOSTON, MASS. 316 STUART ST Spartanburg, S. C.

TREND OF AFFAIRS

(Concluded from page 470)

The state of the Association, and its progress during the past year, were reported in detail by Mr. Lobdell. This report is too long to include in the pages of The Review, but copies were distributed to members of the Alumni Council.

Upon conclusion of the business portion of the meeting, E. Neal Hartley, Associate Professor of History in the Institute's School of Humanities and Social Studies, discussed the humanities program at the Institute. In his talk, he emphasized that the Department of Humanities is not trying to: (1) provide the M.I.T. student with a superficial coating and a facility for name dropping; (2) provide a diluted version of the humanities disciplines or provide the undergraduate a small-scale liberal arts training; (3) offer utilitarian subjects, such as public speaking – although such subjects are offered at the Institute without humanities credit and usually are offered in the professional science and engineering departments; or (4) offer a program in opposition to the engineering and science program at M.I.T.

By and large, the Humanities Department has gotten away from the data-memorizing and the lecture system. Most of its subjects are handled in smaller discussion sections where the classics can be discussed from the point of view of the positions and choices that were open to mature adults during the past 15 centuries. Professor Hartley cited a few examples of the type of books which are studied (especially those available in the paper-bound editions) and offered to provide the titles of books which have been used effectively with the students.

The de Florez Company, Inc.
200 Sylvan Ave. (Route 9W)
Englewood Cliffs, New Jersey

Engineering Development
Processes Machines

Luis de Florez '12 Peter de Florez '38
Owen L. Gore '42 Edwin K. Smith '39
Frank J. Anastasio '47

meissner Engineers

consultants • engineers • constructors

Processing plants. Bulk materials handling and storage. Conveying systems. Ore and minerals processing. Bridge, expressway and interchange design.

JOHN F. MEISSNER ENGINEERS, INC.
300 West Washington Street
Chicago 6, Illinois
ANdover 3-1944

R. C. MEISSNER '43

PROFESSIONAL CARDS

JACKSON & MORELAND, INC.

Engineers and Consultants

DESIGN AND SUPERVISION OF CONSTRUCTION

REPORTS—EXAMINATIONS—APPRAISALS

MACHINE DESIGN—TECHNICAL PUBLICATIONS

BOSTON NEW YORK

GANNETT FLEMING CORDDRY AND CARPENTER, INC.

Engineers

HARRISBURG, PA.

Branch Offices:

Pittsburgh, Pa. Daytona Beach, Fla. Philadelphia, Pa.

Expressways, Toll Roads, Bridges and Airports. Traffic & Parking. Dams, Water Works, Sewage, Industrial Wastes and Garbage Disposal. Appraisals, Investigations and Reports.

EADIE, FREUND & CAMPBELL

CONSULTING ENGINEERS

500 FIFTH AVENUE NEW YORK 36, N. Y.

Mechanical — Electrical — Sanitary

Air Conditioning — Power — Process Layouts

James K. Campbell '11

METCALF & EDDY

Engineers

Water, Sewage, Drainage, Refuse and Industrial Wastes Problems

Airports, Laboratory, Valuations

Statler Building, Boston 16, Mass.

THE KULJIAN CORPORATION

Consultants • Engineers • Constructors

UTILITY • INDUSTRIAL • CHEMICAL

Power Plants (Steam, Hydro, Diesel), Textile Plants, Water & Sewage Works, Oil Refineries, Pipe Lines, Army & Navy Installations, Air Fields, Hangars

H. A. Kuljian '19 A. H. Kuljian '48

1200 NO. BROAD ST., PHILADELPHIA 21, PA.

FABRIC RESEARCH LABORATORIES, INC.

Research, Development, and Consultation

In the Fields of Fibrous, Organic, and Related Materials

1000 Providence Highway Dedham, Mass.

(At Route 128 and U.S. 1 Interchange)

W. J. HAMBURGER, '21 K. R. FOX, '40 E. R. KASWELL, '39

GILBERT ASSOCIATES, INC.

ENGINEERS AND CONSULTANTS

Malcolm G. Davis '25, *Vice President*

Allen W. Reid '12 E. C. Edgar '35

Steam, Hydro, Diesel Power Plants; Industrial Structures; Plant Safety, Utility Rates, Valuations, Reports; Large Scale Purchasing; Chemical Laboratory

New York • READING, PA. • Washington

FAY, SPOFFORD & THORNDIKE, INC.

Engineers

Airports, Bridges, Turnpikes

Water Supply, Sewage and Drainage

Port and Terminal Works, Industrial Buildings

Designs Investigations

Supervision of Construction

Boston, Massachusetts

CLEVERDON, VARNEY & PIKE

Consulting Engineers

HERBERT S. CLEVERDON '10 WALDO F. PIKE '15

JOHN A. DOW '23 HAROLD E. PROCTOR '17

Structural Designs Foundations

Heating, Ventilating, Electric and Plumbing Designs, Industrial Buildings, Reports, Investigations

120 TREMONT STREET BOSTON 8, MASS.

MAURICE A. REIDY

Consulting Engineer

BRIDGES BUILDINGS

STRUCTURAL DESIGNS FOUNDATIONS

CONSTRUCTION CONSULTANT AND ARCHITECTURAL ENGINEER

Estimates and Appraisals

101 TREMONT STREET BOSTON, MASS.

CHARLES NELSON DEBES AND ASSOCIATES

ENGINEERS AND CONSULTANTS

Architectural — Mechanical — Electrical — Structural — Sanitary

Industrial, Commercial and Municipal Projects

915 EAST STATE ST. ROCKFORD, ILL.

C. N. DEBES '35

MORAN, PROCTOR, MUESER & RUTLEDGE

CONSULTING ENGINEERS

Foundations for Buildings, Bridges and Dams; Tunnels, Bulkheads, Marine Structures, Soil Studies and Tests; Reports, Design and Supervision

WILLIAM H. MUESER '22 PHILIP C. RUTLEDGE '33

415 Madison Ave., New York 17, N. Y.

BREWER ENGINEERING LABORATORIES

Consulting Engineers

Electric Strain Gage Testing • Stress Analysis

Strain Gage Amplifiers • Strain Gage Switches

High Temperature Strain Gages

MARION, MASS. TEL. 103

G. A. Brewer '38 S. P. Cammack '37

CAPITOL ENGINEERING CORPORATION

CONSULTING ENGINEERS

Design and Surveys

Roads and Streets

Sewer Systems Water Works

Planning Airports

Bridges • Turnpikes • Dams

Executive Offices

DILLSBURG, PENNSYLVANIA

Washington, D. C. Saigon, Vietnam Rochester, N. Y.

Robert E. Smith '41, Vice President

and the prophet replied:
*"It is well to give when asked, but it is better to give unasked, through understanding."**

Gifts by Will

TO THE

Massachusetts Institute of Technology

The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and project his usefulness to his fellowmen far into the future.

The Massachusetts Institute of Technology because of the high quality of the education given its students, its effective research work for aiding America in peace as well as in war, and the high character of its governing body and academic staff qualifies as an institution for serving our American ideals for the present and in the years to come.

But the search, the finding, and the anticipated accomplishments are not enough; for without the properly-worded record, man's plan for the future may go awry. Hence the prophet's importuning, "— give now," should be heeded. The giving need not be an immediate physical transaction, for written directions replace the spoken word when the speaker is no longer present, and a donor can frequently make by will a gift which is larger than he can make while living. Truly, *"it is well to give when asked, but it is better to give unasked, through understanding."*

A booklet "Gifts by Will," outlining different forms of bequests to M.I.T., is available to you or to your attorney by writing to:

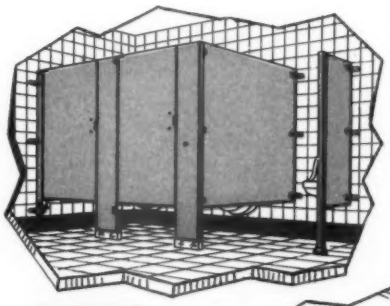
Director of Development
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

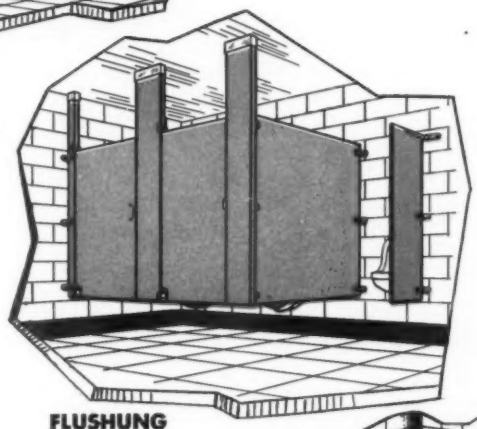
* "The Prophet" by Kahlil Gibran

PIONEERS
FOR
27 YEARS

• toilet partitions
• hospital cubicles
• shower compartments

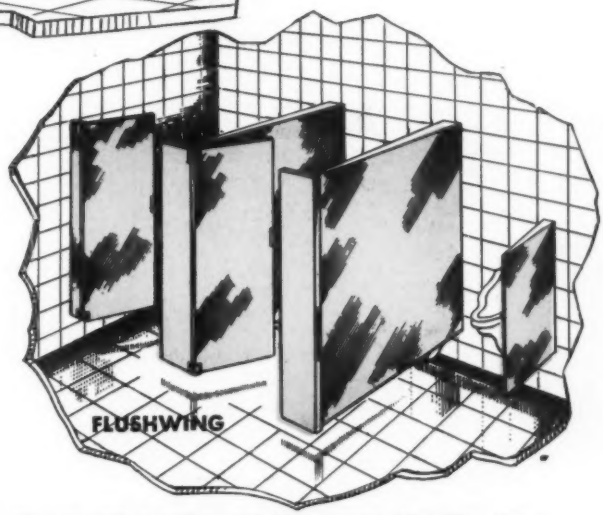
Write for Catalog No. 58


FLUSHART


FLUSHUNG

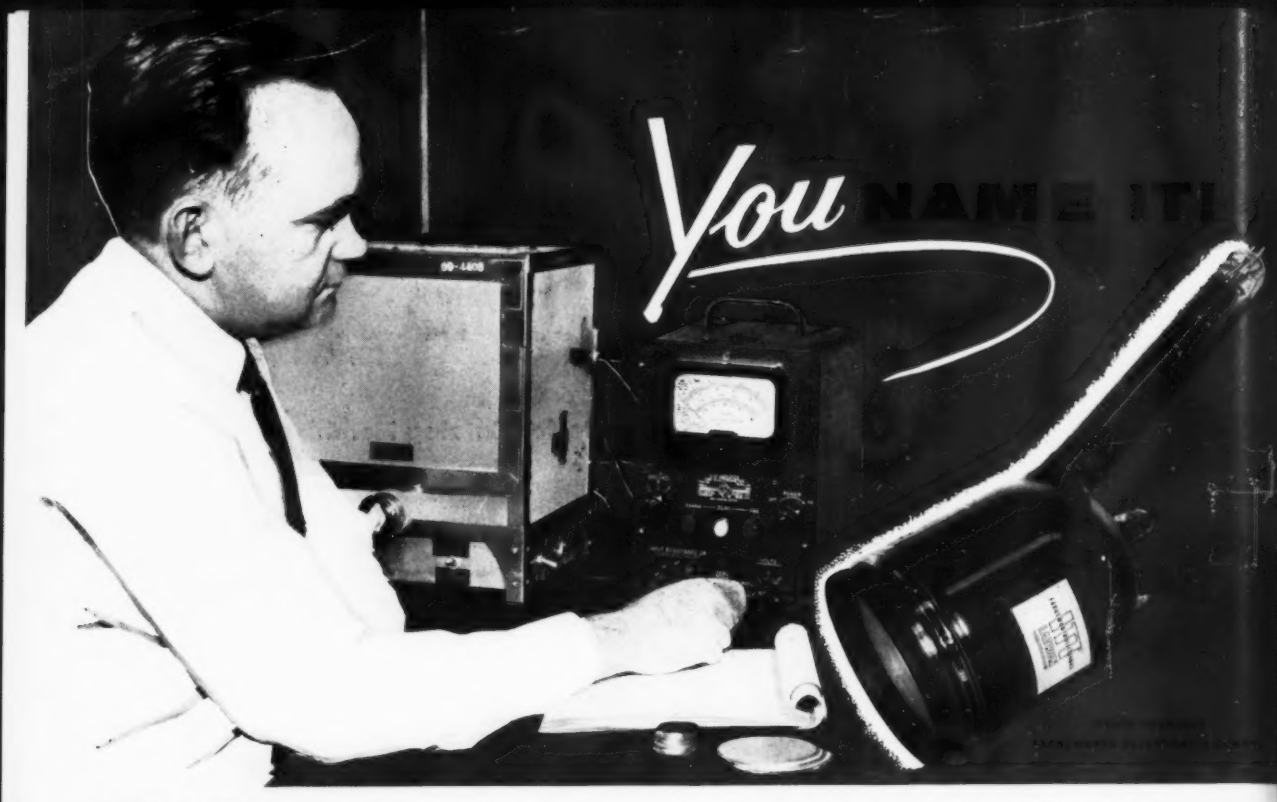
toilet partitions in:

- *stainless steel*
- *synthetic baked enamel*
- *stainless steel and baked enamel in combination*


FLUSHWING

Nathan Schooler '24
Jerome P. Schooler '56

FLUSH-METAL PARTITION CORP.
46-10 11th STREET LONG ISLAND CITY 1, N. Y. STILLWELL 4-3380



Milli-voltmeter, Micro-microammeter, Mega-megohmmeter, or D-C amplifier

Electrical leakage of silicon-oxide storage surfaces used in Farnsworth's Iatron Tubes is measured by the sensitive and stable G-R Electrometer and D-C Amplifier. The Electrometer's direct calibration in ohms, stable, built-in voltage source which is low enough to prevent breakdown in thin films, and the ease with which it can be switched for either polarization-voltage evaluations or resistance-linearity checks, have all proven valuable time and money saving features in production, as well as development.

Type 1230-A D-C Amplifier and Electrometer . . . $440

Typical of this instrument's uses are measurements of ionization currents, grid currents in electron tubes, piezoelectric and contact potentials, and back resistance of silicon-junction diodes. A low-cost instrument of high performance has not been previously available for such work.

. . . we call this instrument the

Type 1230-A D-C Amplifier and Electrometer

It measures *directly* voltages as low as 0.5 mv, currents as low as 5×10^{-15} amp, and resistances as large as 5×10^{14} ohms. No vibrating parts — the G-R Electrometer is a true direct-coupled amplifier. It has high sensitivity and excellent stability — drift is less than 2 mv per hour after one-hour warmup. High input resistance, even under conditions of high humidity, are achieved by use of: an electrometer tube in the first of three direct-coupled stages (input grid lead is enclosed in silicone-treated glass); and switch contacts mounted on individual teflon bushings set in a metal base that connects to a guard point.

Besides its multipurpose abilities, the Electrometer is convenient to use. Its switching arrangement allows you to change functions rapidly . . . from high-impedance voltmeter, to low-impedance ammeter, or to a megohmmeter, *without need of accessory multipliers or shunts*. Other conveniences include built-in resistance standards for current and resistance measurements, and for calibration. Guard terminals are provided so that either 2- or 3-terminal measurements may be made. Output jacks, at the rear, permit use as a sensitive d-c amplifier to drive graphic recorders having input resistances up to 1500Ω (5-ma models can be connected directly).

Voltage Ranges: ±30 mv, 100 mv, 300 mv, 1 v, 3 v, and 10 v; dc, full scale. Accuracy is ±4% of full scale on 30 mv range, ±2% on all other ranges.

Current Ranges: ±300 milli-micromicroamperes d-c (3×10^{-13} amp) full scale to ±1 milliampere full scale in twenty ranges (two per decade). Full-scale accuracy is ±3% to ±10% depending on multiplier position.

Drift: Less than 2 mv per hour after one-hour warmup.

Resistance Ranges: 300 kilohms to 30 megamegohms ($3 \times 10^{13}\Omega$) in 16 ranges. Accuracy is ±3% to ±10% depending on multiplier and on meter deflection. With external 600 v battery in place of the internal 9 v source, resistance range can be extended to read $1.2 \times 10^{17}\Omega$ at smallest meter division.

Write For Complete Information

Input Resistance: Determined by setting of resistance standards (ohms multiplier) switch: 10^4, 10^5, 10^6, 10^7, 10^8, 10^9, 10^{10} and $10^{11}\Omega$; also "zero" and "infinity" positions. At "infinity" position, it is approximately 10^{14} ohms.

Output: Voltage, current, and resistance are indicated on a panel meter. Terminals provided for use with graphic recorders having resistances up to 1500Ω.

Temperature, Humidity, Line Voltage Effects: Negligible.

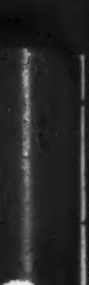
GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U. S. A.

GR 2-Year Warranty on every Product

NEW YORK AREA: Tel. N. Y. WOrth 4-2722, N. J. WHitney 3-3140 **CHICAGO:** Tel. VIllage 8-9400
PHILADELPHIA: Tel. HAncock 4-7419 **WASHINGTON, D. C.:** Tel. JUniper 5-1088
SAN FRANCISCO: Tel. Whitecliff 8-8233 **LOS ANGELES 38:** Tel. HOllywood 9-6201
In **CANADA, TORONTO:** Tel. CHerry 6-2171

WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.



th's Jatron
Amplifier.
urce which
hich it can
e-linearity
production.

r

nces as
plifier.
armup.
ectrom-
glass);
cts to a

gement
ce am-
niences
ration.
Output
put re-

tting of re-
r) switch:
nd $10^{11}\Omega$;
s. At "in-
10^{14} ohms.
stance are
inals pro-
ers having

e Effects:

trict Sales
especially
of instru-
est suited
nquiries —